

IMPOSSIBLE PLANETS

Billions of worlds,
all of them WEIRD

ULURU

So much more
than a big rock

SECRETS OF THE YETI

The real science
behind the myth

AUSTRALIAN

SCIENCE ILLUSTRATED

THOUGHT CONTROL

Could it cure every
mental illness?

MEMORY EFFECT

Would you erase
a bad memory?

THE GENIUS GENE

Are we all potential
Einsteins?

SWEET DREAMS

The real reason
sleep is so
important

AMAZING NEW DISCOVERIES!

KEYS TO THE MIND

Unleashing the true potential of **THE HUMAN BRAIN**

FROM HUNTERS TO FARMERS

How humans discovered agriculture...
and changed the world

ISSUE #35

INSTANT EXPERT

TITAN

EVERYTHING YOU NEED TO KNOW
ABOUT SATURN'S FAMOUS MOON

- Why we went there
- Our future plans
- A second home?

PLUS! ANTARCTIC ARCHAEOLOGY // THE ASTOUNDING MANTIS SHRIMP // AN AUSSIE SNAKE WRECKS PARADISE // THE MOON'S VOLCANIC PAST

ELEVEN WORDS THAT SPARKED A REVOLUTION

“Wait a minute, wait a minute,
you ain’t heard nothin’ yet.”

Al Jolson’s first spoken words in *The Jazz Singer* mark the first appearance of synchronized dialogue in a feature-length motion picture. Art mirrored life. Moviegoers truly hadn’t heard anything like this before. And when they did, they wanted to hear more. *The Jazz Singer* had less than two minutes of spoken dialogue. But it sparked a revolution nonetheless.



The Jazz Singer, 1927

SOUND CHANGES EVERYTHING

Pictures are pictures. Pictures with sound are transformational. That’s why *The Jazz Singer* hit Hollywood like a seismic wave. In its wake, silent films have all but disappeared.

Sound Changes Everything. Again.

The new Zoom Q8. Think of it as a go-everywhere video camera with 4-track audio. Think of it as a record-everywhere studio with HD video. Better yet, think of the possibilities.

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SCIENCE ILLUSTRATED

Issue #35 (5th March 2015)

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THE SCIENCE ILLUSTRATED CREDO

We share with our readers a fascination
with science, technology, nature, culture
and archaeology, and believe that through
education about our past, present and future,
we can make the world a better place.

It's All in Your Mind



Someday, in the future, maybe the far future, we'll understand the human brain. We'll understand what every structure in it does, how the parts interact, where

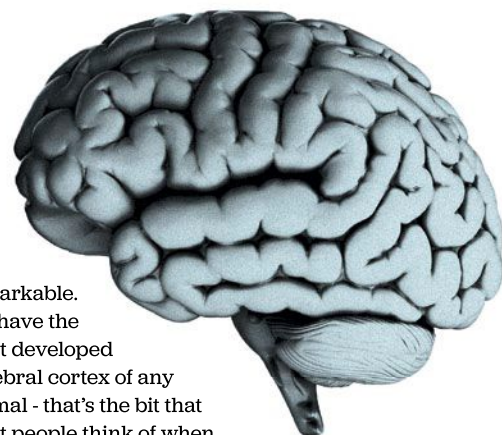
our consciousness resides, how memories work, and why every brain is so different. It's amazing to think (heh) that despite all our knowledge and technological sophistication, despite what we've worked out about the structure of the universe and the inner workings of the atom, we still don't know exactly how the brain works. At least, not really. We know lots about various bits of the brain. And we're slowly getting an idea of the magnitude of the task ahead.

The biggest question of all might be this: why has the HUMAN brain allowed our species to do so much, to become so advanced, to - good or bad - dominate the planet like no species before us? We don't have the biggest brains in the animal kingdom, and our close relatives the great apes have brains that, on the surface at least, appear only slightly different.

And yet, in a way, it's the human brain that has created, well, everything. Think about it: everything you know to be true about the world, about life, about the universe has first been filtered through your brain. Nothing that has ever been said or written or filmed hasn't first rattled around in the brain of a human.

Not bad for a lump of hydrocarbon goo that weighs about a kilo and a half.

Okay, saying that there are animals with other brains that aren't so different from ours is a bit misleading. In fact our brains are pretty



remarkable. We have the most developed cerebral cortex of any animal - that's the bit that most people think of when they use their brain to picture a brain. Wrinkly, grey, it allows us to perceive the world and act on our perceptions.

As for total brain size, it's true that some whales have heavier brains that take up more space than ours, but it's not as simple as that. A measure called the "encephalisation quotient" takes into account relative body sizes and the fact that our bodies are a certain shape because we live on land, walk upright etc.

When you take those things into account, the human brain is, effectively, twice as big as a dolphin's and three times bigger than our close relative the chimpanzee.

Neuroscientists can point to all sorts of structures and systems in the brain, right down to a cellular level, but the answer to the basic question "which part makes me, me?" still eludes them.

Why does it matter? Well, as science continues to eliminate disease and extend life, questions surrounding the function of the brain will get more and more pressing. For many people under the age of 40 today, the big challenge for them at their end of their life won't be heart disease or renal failure. It will be deteriorating brain function. Only once we fully understand the brain will we be able to save it.

Anthony Fordham

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THINGS WE LEARNED IN THIS ISSUE

+ Even famous Westerners like **SIR EDMUND HILLARY** believed in legends of the Abominable Snowman

+ On the surface of Titan there are lakes **FULL OF ALCOHOL** albeit cold and poisonous alcohol.

+ Smelling roses can help **IMPROVE YOUR MEMORY...** if you can get enough sleep.

+ Orcas can learn to **SPEAK DOLPHIN**



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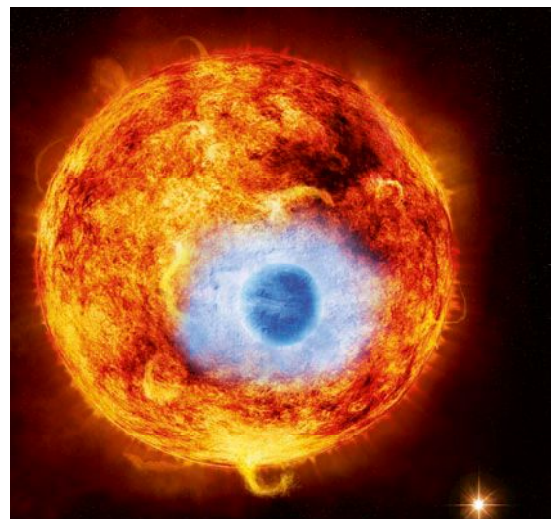
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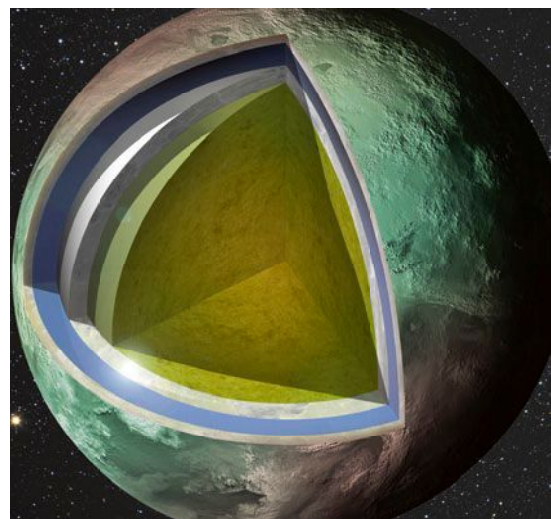
As we discover more exoplanets, it's becoming apparent that our "classical" model of how solar systems form is deeply inadequate. Come and visit some of the weirdest planets...



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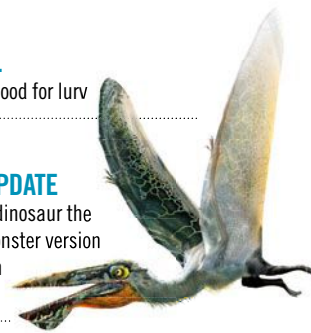
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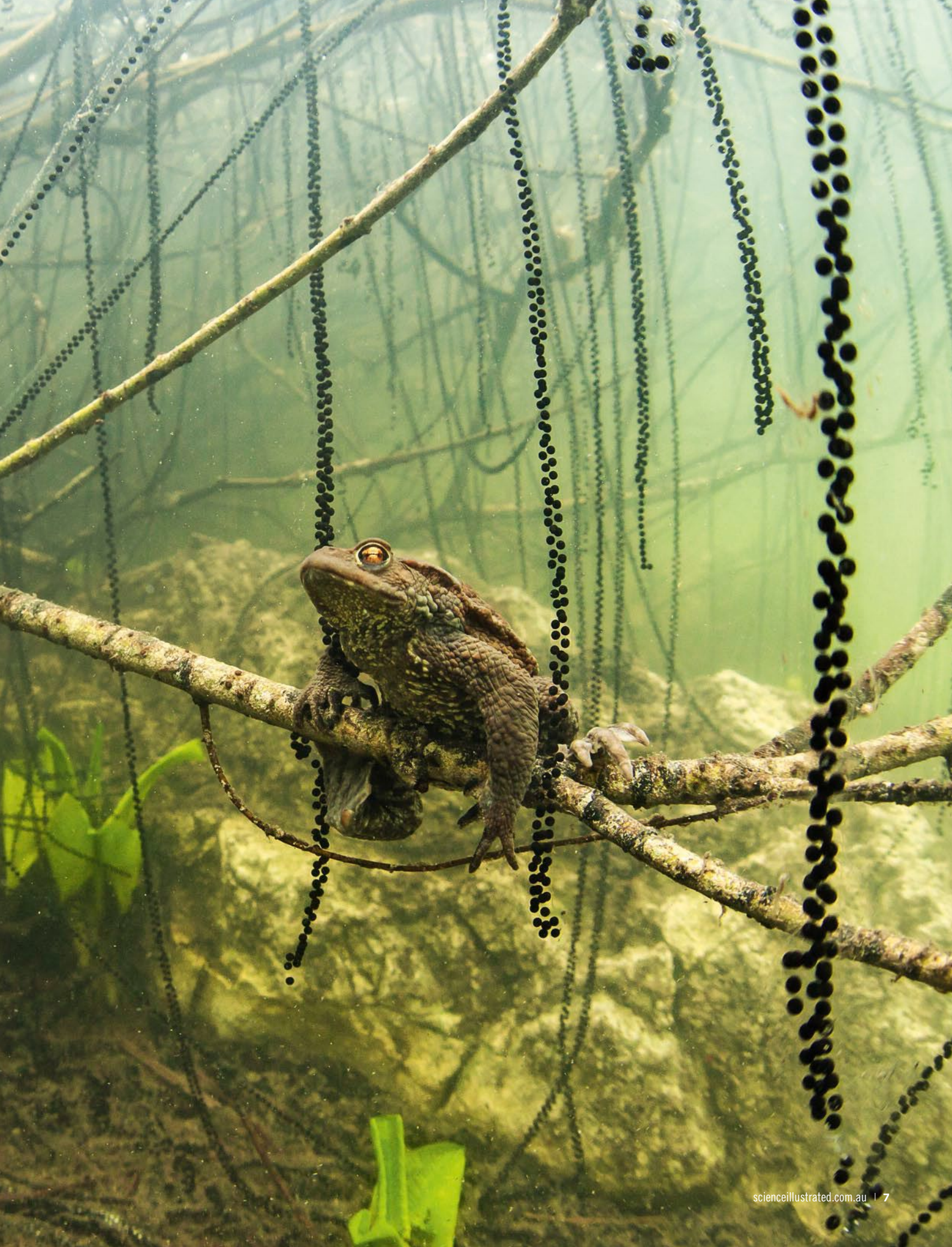
Get Australian Science Illustrated delivered to your door and save \$\$\$\$!



DECORATING THE POND WITH EGG-STREAMERS

Like beads on a necklace, long chains of toad eggs hang from underwater plants at the bottom of a lake. The female toad releases the long egg strands, which are subsequently fertilised by a male who rides along with a firm grip on her back. The croaky couple may travel for days in this way, as the female lays 600 to 4,000 eggs. The strands are wound and stretched around aquatic plants like festival bunting.

R. MASSON/IBROPHOTO



MEGAPIXEL

BIOLOGY





↓ MANTIS SHRIMPS HAVE STRANGE COMPLEX EYES

The Mantis shrimp is renowned for having strangely complex vision. Their eyes include 12 different colour receptors - compared to just three in human eyes. Apart from being able to see countless colours, the complex eyes are extremely good at perceiving polarised light. Yet bafflingly, the latest experiments show that the Mantis shrimp - or stomatopod - cannot recognise as many different colours as humans. Current theory suggests the extra colour receptors may allow the stomatopod to identify colours very quickly, without needing to use the computational centres of its brain. This could give it a speed advantage when hunting.

TEGUNA TRIVARUTRA

Editors: Julie Hjerl Hansen

JAY DICKSON/BROWN UNIVERSITY

VAST LAVA FLOWS CREATED THE BIGGEST LUNAR MARE

NASA scientists have made a sensational discovery: The biggest lunar mare is not an impact crater, as previously believed.

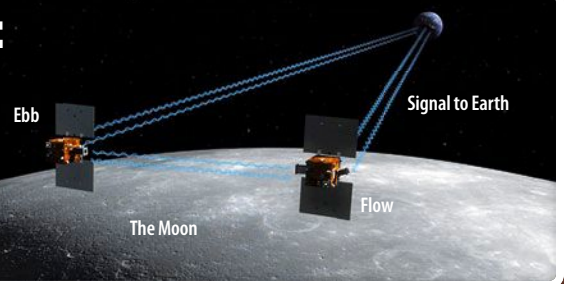
ASTRONOMY Astronomers must rewrite the history of the Moon after NASA scientists made a ground breaking discovery. So far, the dominant theory has claimed that the biggest lunar mare, Oceanus Procellarum, was created in a violent collision between the Moon and an asteroid in the chaotic early history of our Solar System.

Data from two NASA space probes, Ebb and Flow, shows that the approximately 2,600-km-wide mare is surrounded by long cracks filled with lava and making up a huge square. If the mare had emerged as the result of a collision with an asteroid, its perimeter would have been oval or circular. Instead, astronomers now believe that the huge lunar mare was created in the wake of violent geological activity

shortly after the formation of the Moon. Just like when the tectonic plates on Earth move, triggering earthquakes, violent geological powers affected the Moon's crust, making it crack. Red-hot lava flowed out of the cracks and flooded the region of the Moon, which is now known as Oceanus Procellarum.

TWIN PROBES SOLVE LUNAR MYSTERY

In 2012, the Ebb and Flow space probes orbited just 55 km above the Moon's surface. As the distance between the probes changed, scientists spotted differences in the Moon's gravitational field, providing new data of how the Moon's biggest mare was formed.



POOP PILL CAN CURE DANGEROUS INTESTINAL INFECTION

Frozen faeces pills can cure a severe and in some cases fatal bacterial infection which causes diarrhoea. That is the result of an experiment in which 20 patients received the odd therapy: 18 were cured- a success rate of no less than 90%.

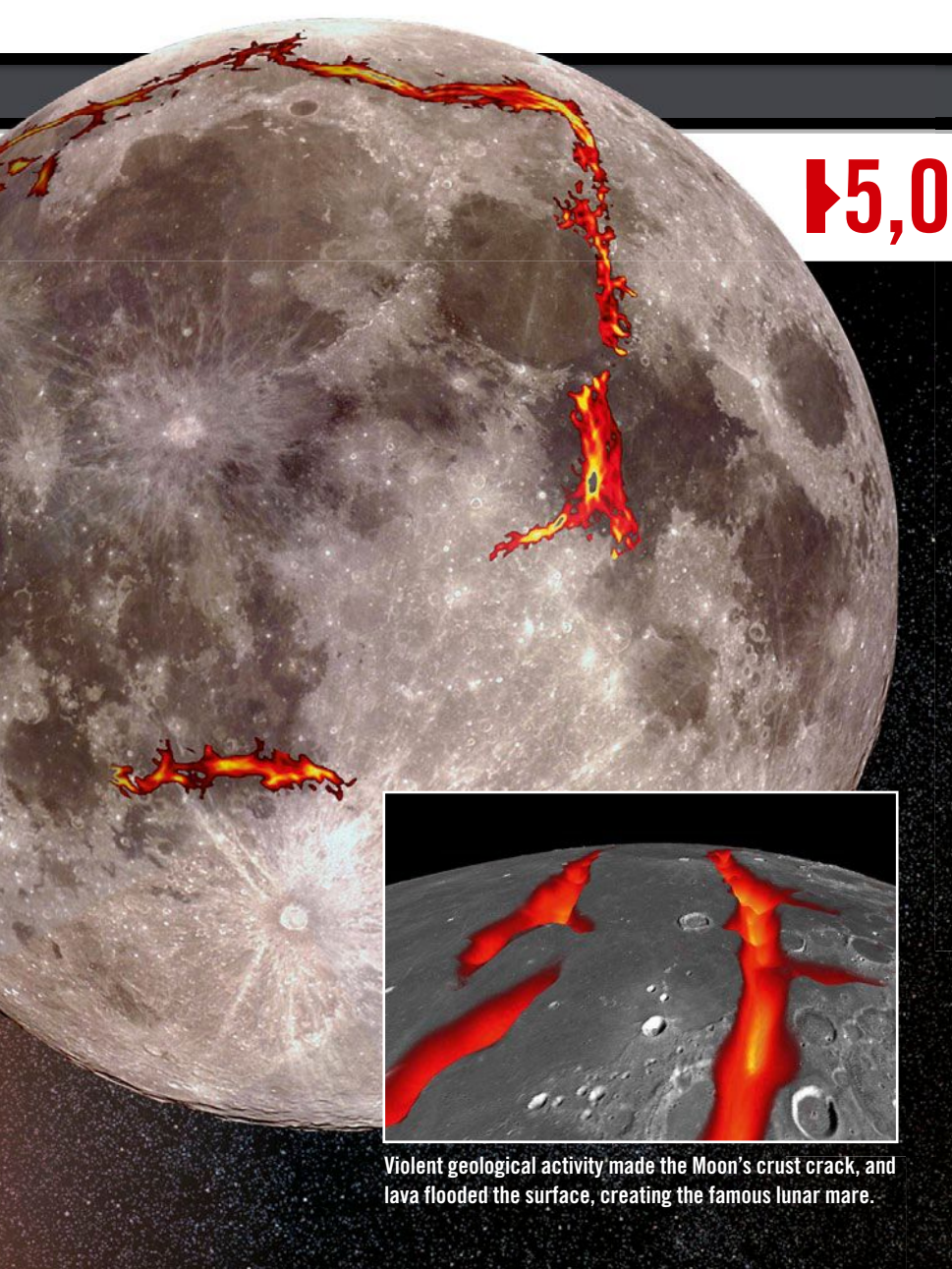
Until now, the treatment of the disease involved transplanting faeces to the patient's intestines by means of endoscopic surgery or via a tube through the nose.

HORMANN LAB

► NEWS FLASH!

LIGHT BEHAVES LIKE SOLID AND LIQUID

Scientists have long known that light can occur as both particles and waves. Now, scientists from the American Princeton University have managed to make light behave in the same way as solid matter and liquid. But though the light behaves like this, it has neither turned into solid matter, nor liquid.



Violent geological activity made the Moon's crust crack, and lava flooded the surface, creating the famous lunar mare.

5,000 -year-old cat bones have been found in a grave. The discovery demonstrates that humans kept cats earlier than we thought.

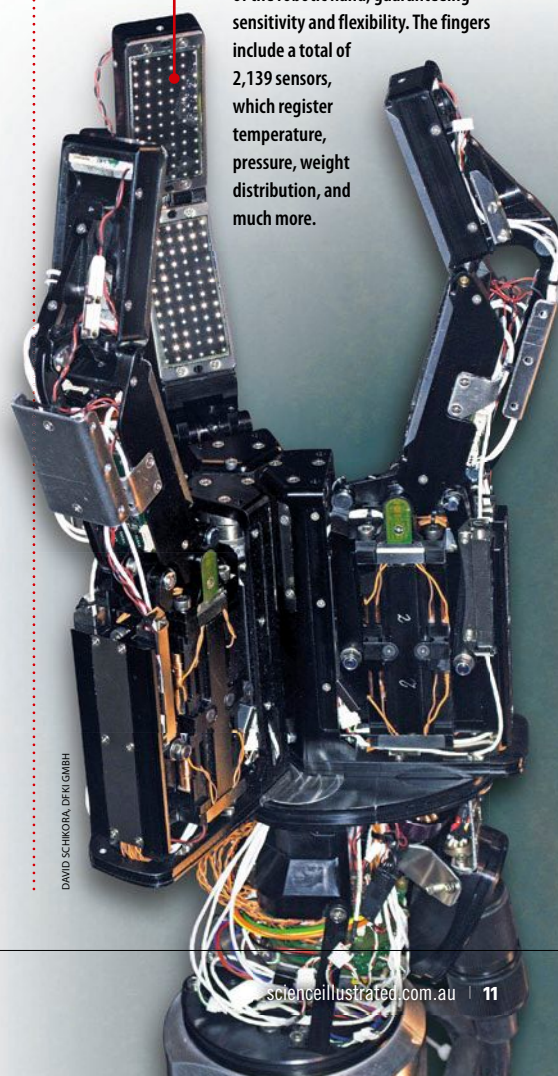
Robotic hand explores the deep seas

TECHNOLOGY A new, sophisticated robotic hand, the SeeGrip, can literally feel its way through the darkness of the deep seas. Its three fingers feature integrated sensors that function as a sense of touch. The robot will explore inaccessible corners of the deep seas and repair defective oil or gas wells, etc.

Scientists from the Research Centre for Artificial Intelligence in the German city of Bremen have developed the robotic hand, which can be mounted on a submarine and used as deep as six kilometres. Computer software converts data from the sensors into a digital image of the object touched by the robot. In a test in which the robotic hand felt a cup, a toy shark, and a chess piece, it guessed right nine times out of ten.

FINGER SENSORS MEASURE PRESSURE AND TEMPERATURE

A thin coating covers the fingers of the robotic hand, guaranteeing sensitivity and flexibility. The fingers include a total of 2,139 sensors, which register temperature, pressure, weight distribution, and much more.



DAVID SCHIKOTA, DFR GMBH

CROCODILES COOPERATE TO CATCH PREY

ZOOLOGY Only a few animal species such as dolphins, killer whales, and lions are able to cooperate on a carefully coordinated attack on prey. But new scientific results show that crocodiles cooperate in teams

too, when they hunt. Crocodiles' hunting technique is hard to study in the wild. So, Vladimir Dinets from the University of Tennessee in the US has used social media to collect eyewitness accounts of how crocodiles hunt in groups.

One of the crocodiles scares the prey, which flees into the water, where the rest of the hungry gang is waiting, or a group of crocodiles circle a shoal of fish, so the fish cannot escape.

Crocodiles help each other catch fish, frogs, and big prey.



NATURE PL

► NEWS FLASH!

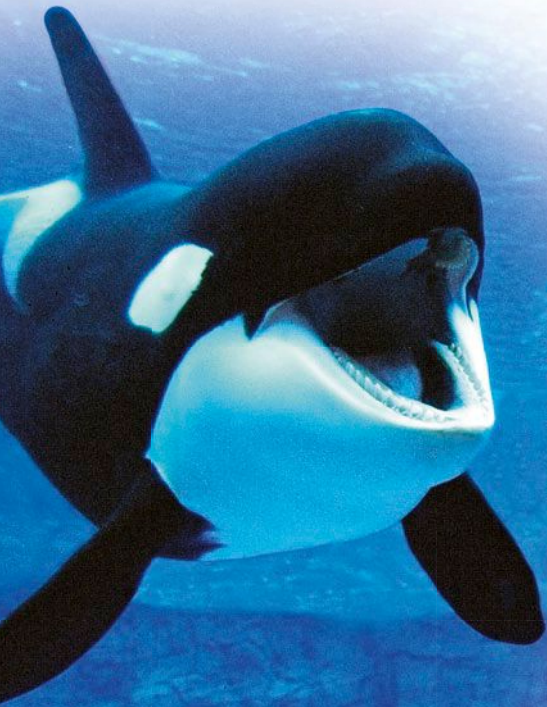
PARTICLE IS ITS OWN ANTIPARTICLE

In 1937, Italian physicist Ettore Majorana predicted that there is a particle which is also its own antiparticle. A particle's antiparticle weighs exactly the same, but has the opposite electric charge. Scientists from Princeton University in the US now claim to have found such a particle.

KILLER WHALES SPEAK DOLPHIN

IMAGESELECT

Killer whales are able to imitate sounds made by bottlenose dolphins. New scientific research demonstrates that killer whales kept in captivity along with bottle-nose dolphins give up their own sounds after a period of time and start communicating like their fellow prisoners.



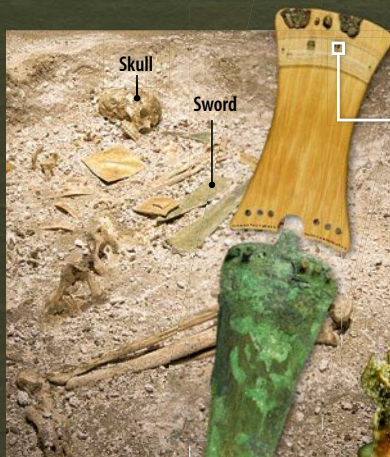
CHILDREN MADE TREASURES FOR STONEHENGE GRAVE

The making of gold treasures required sharp eyesight.

ARCHAEOLOGY Extremely detailed gold adornment of treasures found in 1808 in a burial mound near Stonehenge were probably made by children, experts conclude. The gold treasures from the Bush Barrow mound near Stonehenge are among the most precious Bronze Age treasures ever found. The treasures belonged to a local clan leader, who was buried almost 4,000 years ago. He was accompanied by a sword, whose handle was lined with 140,000+ tiny gold spangles. Every part of the sword handle was covered in 1,000+ tiny gold spangles carefully placed in a zigzag pattern. According to a leading British optician,

Ronald Rabbets, only children and extremely near-sighted adults would have been able to place the gold spangles, which are only 1 mm long and 0.2 mm wide, correctly.

According to experts, the adornment effort must have required approximately 2,500 working hours, and it was so stressful, that it may have damaged the eyesight of the children.



The 27cm-long sword was found near Stonehenge along with other gold treasures and the skeleton of a local clan leader.

DAVID BUKACH & UNIVERSITY OF BIRMINGHAM



We judge people's personalities in just split seconds based on their voices, according to new scientific research from the University of Glasgow.

7 days is the time it took a team of scientists to grow fully functional blood vessels using stem cells from blood.



SCANNIX

This baby is the first in the world born from a transplanted uterus.

FIRST BABY BORN AFTER UTERUS TRANSPLANT

MEDICINE A 36-year-old Swedish woman is the first ever to have given birth to a baby after a uterus transplant. The new mother was born without a uterus, but with ovaries. A 61-year-old, unrelated woman donated her uterus, and after the transplant, the Swedish woman's own eggs, which had been fertilised in a test tube with her boyfriend's sperm, were inserted.

Due to pregnancy toxemia, the baby was born in a caesarean delivery eight weeks prematurely. Despite only weighing some 1.8 kg at birth, today the boy is healthy and developing normally.



LOCAL FOCAL POINT

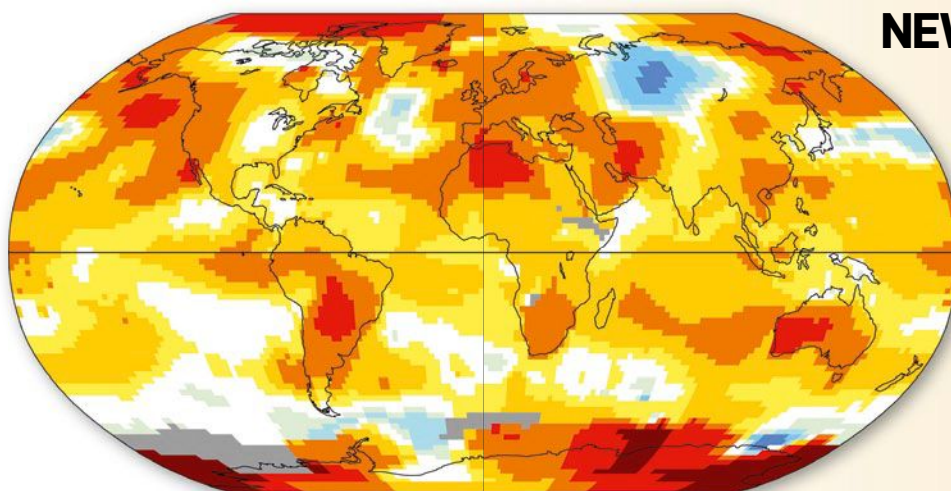
Bárðarbunga, Iceland



OLIVER GRUNEWALD

Solar storms colour the sky above Icelandic volcanic eruption

In September, auroras coloured the sky above the Icelandic Bárðarbunga volcano. The reddish and orange hues were due to the volcanic eruption, which illuminates the sky. Usually, auroras colour the sky green, but in case of particularly violent solar storms, purple hues can also be observed.



-4.1 -4 -2 -1 -0.5 -0.2 0.2 0.5 1 2 4 8.7 °C

The map indicates the deviation from the average September temperature. All the orange and reddish hues reveal that September 2014 was unusually warm.

NEW HEAT RECORD IN SEPTEMBER

CLIMATE Global climate data have been collected since 1880, and during that period, the world has never seen a September as warm as in 2014. During the first month of autumn, temperatures were on average 1.4 degrees higher than the average temperatures of September 1951-1980. So, September 2014 was the warmest September ever measured. The previous record was set in 2005.

Source: NASA

The brains of children, who later become autistic, begin to change before they were born, according to new US research.

TITAN'S VORTEX CONSISTS OF TOXIC GAS

ASTRONOMY In 2012, Cassini, a NASA space probe, discovered a huge, rotating vortex in the outer atmosphere high above the south pole of Saturn's moon Titan. After analysing data from the space probe, a team of astronomers discovered the make-up of the vortex. Surprisingly, the vortex holds frozen prussic acid particles, which are very toxic.

According to scientists, the discovery means that Titan's outer atmosphere is much colder than expected.

Scientists think that the temperature is some minus 148 °C, or 100 degrees colder than previously believed. In 2004, when Cassini started to orbit Saturn, the probe found a similar vortex at Titan's north pole. So, astronomers assume that the vortex is a seasonal phenomenon.

The vortex was spotted in 2012, 300 km above Titan's south pole. It could be a recurring seasonal effect. For more on Titan this issue, flip to page 64

STRANGE

— BUT TRUE!



Flies inherit features from mother's lovers

Flies cannot hide their affairs. Even when eggs are fertilised by one particular male, fly offspring may inherit genetic features from males that the mother has mated with in the past. The offspring may be much bigger than the dad, if the mother once mated with a bigger male.

Disgust reveals political stance

Your reaction to disgusting pictures reveals how you vote in elections, according to a new study. People who react with lots of disgust are often right-wingers.

Pterosaur caught fish with its beak

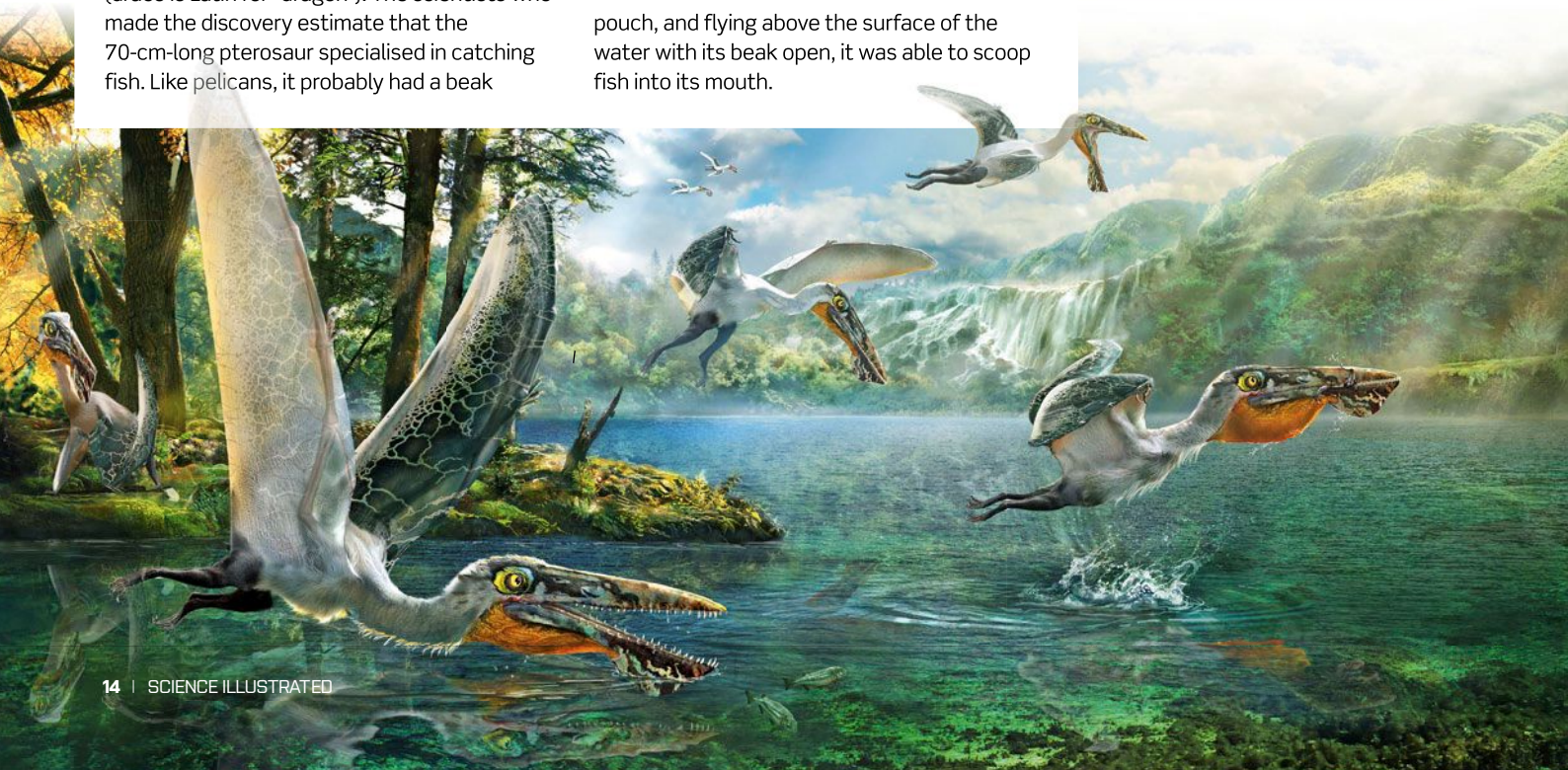
PALAEONTOLOGY In north-eastern China, scientists have found the fossil of a new species of pterosaur, which lived some 120 million years ago. The pterosaur, which has a 1.5 m wing span, is so similar to the flying Ikran creatures in the film *Avatar* that palaeontologists named it *Ikrandraco avatar* (draco is Latin for "dragon"). The scientists who made the discovery estimate that the 70-cm-long pterosaur specialised in catching fish. Like pelicans, it probably had a beak



The beak of the *Ikrandraco Avatar* pterosaur was similar to a pelican's, only with teeth.

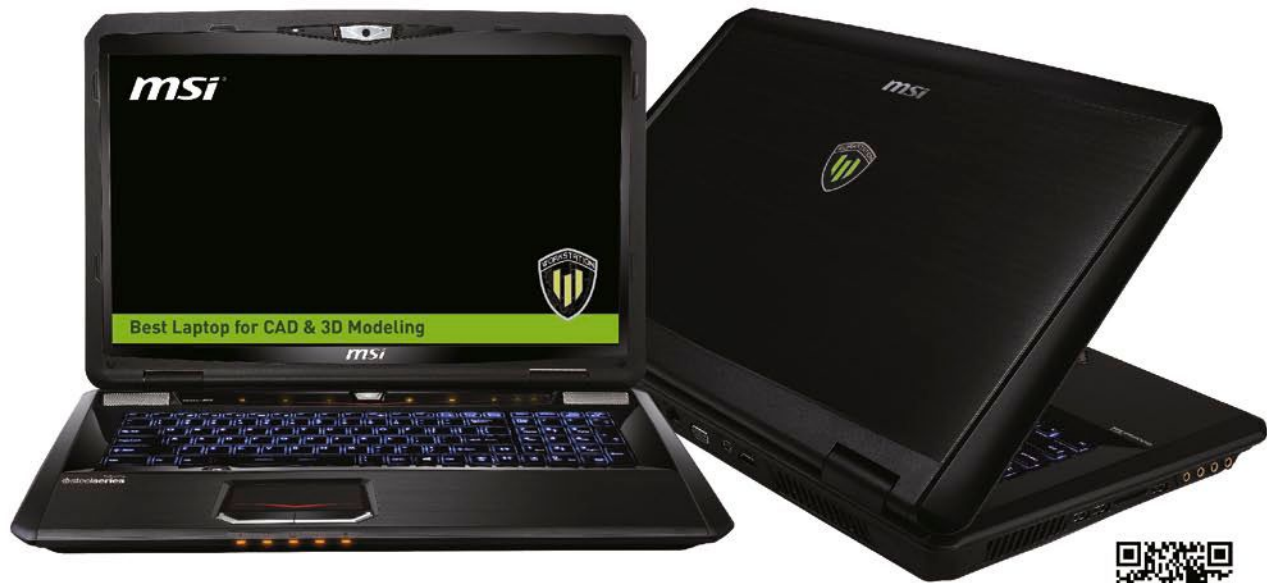
WANG XIAOLIN/CAS/CHUANG ZHAO

pouch, and flying above the surface of the water with its beak open, it was able to scoop fish into its mouth.





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MSI WT70 Workstation Laptop Review by Woolworths

This review is of the loan MSI WT70 laptop, kindly supplied by MSI Australia over the period November - December 2014

Use cases - about Woolworths

Woolworths Limited manages some of Australia's most recognized & trusted brands. We endeavour to create a world class experience for consumers at all levels of our business.

Woolworths Limited manages a wide range of brands, centred around the supermarket, liquor and general retail fields, with a growing portfolio of online brands. Within Woolworths Limited, each brand is responsible for management & planning design of the physical store spaces; each of the major groups has a Planning team. Each Planning team consists of architects, interior designers, industrial designers, project managers and construction professionals.

The main software provider that Woolworths uses for building design & planning is Autodesk, using Autodesk's Building Design Suite.

The Building Design Suite comprises these main packages:

- AutoCad
- Revit
- 3DS Max
- Showcase
- Navisworks
- Infravworks
- Inventor

The main software used is Revit for store planning & design, and 3DS Max for furniture design & visualization.

The WT70 loaned to us was used by three teams:

1. Woolworths Supermarkets Planning Team - primarily Revit (architectural design)
2. Woolworths Supermarkets Industrial Design Team - primarily 3DS Max (furniture / interior design)
3. Woolworths Online Customer Engagement - Unity graphics engine / Oculus Rift

Supermarket Planning Team - Autodesk Revit



Woolworths Supermarkets Industrial Design Team



Woolworths Online Customer Engagement



Overall

From our testing, we can recommend the MSI WT70 as an exceptionally powerful and capable graphics workstation. It has the power and speed of a dedicated desktop workstation, in a good-looking portable laptop. The high-res screen is not only

comfortable to use, it means the user has a great portable presentation screen. The ability to reproduce colours accurately is also very important in the design workflow, and the WT70 excels in this regard.

Woolworths
Australia's fresh food people



▶ **240** km. That is the distance across which elephants can sense an approaching rainstorm, according to elephant migration studies. ◀

↓ ANTARCTICA'S MELTING ICE ALTERS EARTH'S GRAVITY

Climate change and melting ice causes changes to gravity near Antarctica.

CLIMATE The glaciers of Western Antarctica have shrunk so much that it affects gravity, according to new studies of data from the European Space Agency's GOCE satellite. In 2009-2012, the satellite studied Earth's "geode", or gravity field, which varies as it is affected by mountains, deep sea trenches, etc. Now, GOCE measurements show that so many billions of

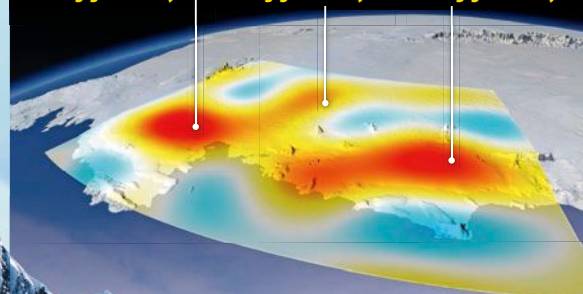
tonnes of ice have disappeared from Western Antarctica's ice sheet that gravity in the region has become weaker.

Moreover, data from another ESA satellite demonstrates that the speed at which the ice sheet is disappearing tripled from 2009 to 2012. If Western Antarctica's ice sheet disappears altogether, it could cause the oceans to rise by more than three metres.

BILLIONS OF TONNES OF ICE DISAPPEAR

Every year, the glaciers and ice shelves of Western Antarctica are reduced by several billions of tonnes of ice, according to measurements from ESA satellites.

Pine Island glacier -67 gigatonnes/yr Thwaites glacier -63 gigatonnes/yr Getz ice shelf -55 gigatonnes/yr



Antarctica is melting so fast that 125 km³ of ice disappears from the frozen continent annually.

SHUTTERSTOCK/ESA

▶ NEWS FLASH!

SUPERCOMPUTER TO PREDICT THE WEATHER.

British scientists are building a huge computer for climate data processing. It will weigh the same as 11 double-decker buses. Weather prediction is extremely demanding and requires enormous processing power.

PROSTHESIS LINKED TO BONE AND NERVES

Scientists from Sweden were the first in the world to build a mind-controlled artificial arm, which is permanently linked to bone, nerves, and muscles. The initial results are very good. A Swedish lorry driver, who was given the prosthesis in January 2013, can now handle a drill and tie his child's shoelaces.

ORTIZ-CATALAN ET AL.



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The Foundation for the Advancement of Astronomy, established by the Astronomical Society of Australia, recognises excellence through the Society's activities.

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- **The Charlene Heisler Prize** for most outstanding astronomy PhD thesis
- **The Louise Webster Prize** for excellence by an early career researcher
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Do all people have different toe-prints?

I have often heard that all people have unique fingerprints. But is that also true for toe-prints, and if so, why?

Like fingerprints, toe-prints are unique. Both prints are formed at the embryonic stage, and the pattern is primarily genetically determined, whereas the details are a result of coincidence. When the embryo is around 10 weeks old, toe and fingertips swell into volar pads, in which blood vessels, connective tissue, and nerves develop. When fingers and toes subsequently grow, the volar pads are

"swallowed". At about the same time, the skin contracts into small folds, which make the skin flexible and produce frictional resistance, aiding us not to slip and to grasp things.

The final print depends on the series of events. If the skin folds before the tip is swallowed, there will be many whorls in the toe or fingerprint. If it happens at the same time, there will be loops, and if the skin folds late, the print is arched. In many jurisdictions, toe-prints are just as valid evidence as fingerprints, but as criminals rarely commit crimes in bare feet, toe-prints are seldom presented as forensic evidence.

COMPUTER MATCHES FINGERPRINTS

Sophisticated mathematical models find the right match.

Today, fingerprints are analysed using sophisticated computer algorithms, which measure the distance between certain features such as arches, matching identical prints. Before the sophisticated models were developed, the comparisons were made manually

based on different classification systems. First, analysts compared finger or toe-prints based on the overall pattern, categorising them into 3 groups. Subsequently, the experts took a look at minor details such as arch steepness.



SHUTTERSTOCK

CAN TALENT BE INHERITED?

Talent is very much genetically determined, particularly as regards math and language, but also when it comes to musical, athletic, and artistic gifts. Scientific results demonstrate that the environment only plays a minor role. If the parents have natural talents for acting or other things, their children will often inherit the gift, which was the case for actor Donald Sutherland's son, Kiefer.



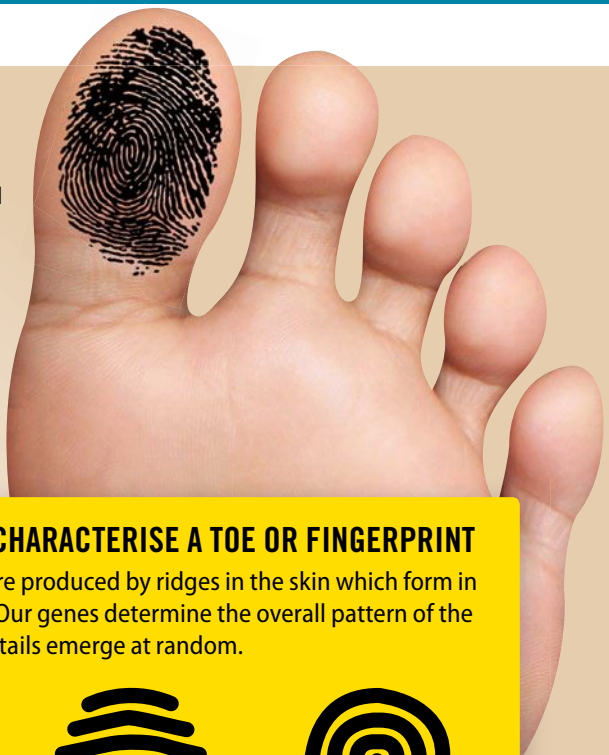
GETTY IMAGES

IN SHORT

HOW MUCH FOREST DID HUMANS CLEAR?

10,000 years ago, 45% of Earth was covered by forests. Today, it is 31%. The forests have shrunk by two billion hectares – an area bigger than Russia. Demand for farm land is the most important reason for the deforestation.

The toe and fingerprints of suspects can be compared to prints found on the crime scene.



THREE PATTERNS CHARACTERISE A TOE OR FINGERPRINT

Toe and fingerprints are produced by ridges in the skin which form in the embryonic stage. Our genes determine the overall pattern of the prints, whereas the details emerge at random.



1 LOOPS
develop, if the skin folds at about the same time as the embryo's toe or finger pulps form.



2 ARCHES
emerge, if the skin does not fold until the toe or finger pulps have developed into their final shapes.

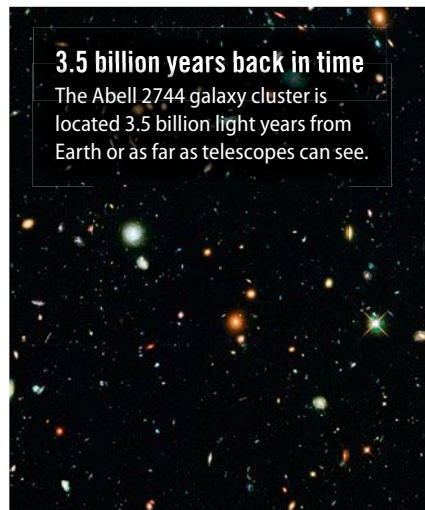


3 WHORLS
occur, if the skin starts to fold, before the toe or finger pulps have developed into their final shapes.

SHUTTERSTOCK

3.5 billion years back in time

The Abell 2744 galaxy cluster is located 3.5 billion light years from Earth or as far as telescopes can see.



NASA

CAN WE SEE EARTH'S BIRTH?

If we can use telescopes to look very far back in time, why can we not see Earth's birth?

When astronomers look back in time, they see objects far away. A telescope captures light that has travelled through space. The distance travelled by light in one year is known as a light year. So, when we look at a star, which is 100 light years away, we see the star as it was 100 years ago. From Earth, telescopes cannot see what our world looked like in the past. Earth is some 4.5 billion years old, so in order to watch its birth, we would have to travel (instantly) 4.5 billion light years into space and look at Earth from there.

TOP5

WHICH BUILDING HAS THE WORLD'S BIGGEST VOLUME?

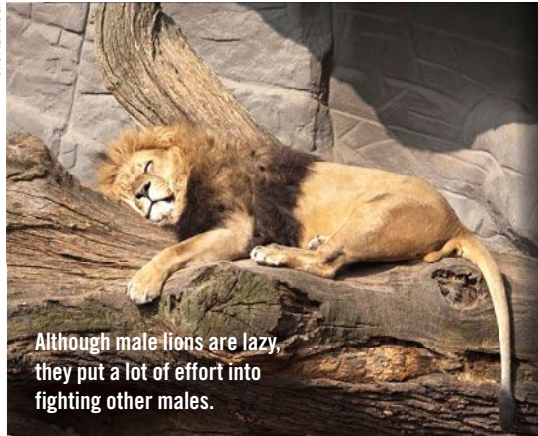
- 1. Boeing Everett Factory**
Washington State, USA: 13.3 million m³
- 2. Target Import Warehouse**
Washington State, USA: 7.43 million m³
- 3. Jean-Luc Lagardère (Airbus assembly)**
Toulouse-Blagnac, France: 5.6 million m³
- 4. Aerium (tropical theme park)**
Brandenburg, Germany: 5.2 million m³
- 5. Meyer Werft Dockhalle 2 (dry dock)**
Papenburg, Germany: 4.72 million m³



The Boeing factory builds the huge Boeing 777 planes.

GETTY IMAGES

SHUTTERSTOCK



Although male lions are lazy, they put a lot of effort into fighting other males.

WHY DO "LAZY" LIONS HAVE BIG MUSCLES?

Although lions spend 18-20 hours a day relaxing, they still have big, strong muscles. The phenomenon may seem surprising, as humans become flabby and weak, if we are lie down 75% of the time. The explanation is to be found in the fact, that lions' muscles are naturally big, unlike a human's. Also, male lions keep in shape by fighting and chasing other males off their territories. The fighting is hard work. A diet lacking in cheeseburgers and soft drink helps too.

Cattle with gene flaw

In mammals, the myostatin protein curbs muscle growth. But some animals have a gene flaw that provides them with extremely big muscles. The phenomenon can be observed in Belgian Blue cattle.



SCANPIX

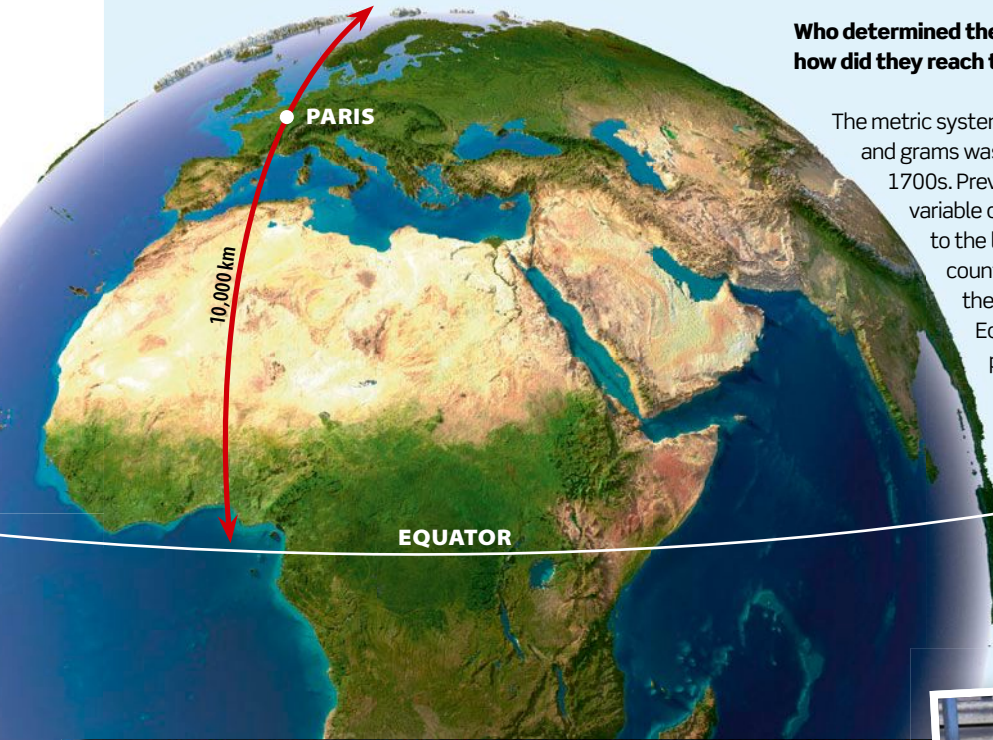
HOW DID UNITS OF MEASURE ARISE?

Who determined the length of our units of measurement? And how did they reach the conclusion that 1 metre is 100 cm?

The metric system, including the basic units of metres, litres, and grams was developed by scientists in Paris in the late 1700s. Previously, the unit of length was based on variable dimensions – such as one foot corresponding to the length of a man's foot, which varied from county to county. The French based their work on the distance between the North Pole and the Equator measured along the meridian that passes through Paris. One metre was defined as one ten millionth of the distance.

The kilogram unit was linked with metres and defined as the mass of four degree warm water which could fit into a volume of 1/1,000 m³. Many countries did not seriously support the metric system until 1875, when the first submarine cable between Europe and the US was installed and began operation.

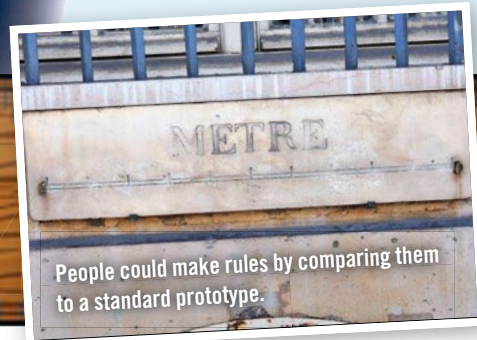
SHUTTERSTOCK, ALAMY/AGESELECT



THE FRENCH WERE FIRST TO KNOW THE METRE

In 1799, France introduced the metric system by law, making a standard platinum prototype, kept in the French National Archives. 16

marble blocks with engraved metres were also erected at different locations in Paris, so people could get used to the new unit of measure.



People could make rules by comparing them to a standard prototype.

What does the world's heaviest rocket weigh?

NASA's Saturn V rocket is the heaviest and the only one to ever send humans to the Moon in connection with the Apollo programme. The three-stage rocket weighs

2,950,000 kg

HOME, SWEET HOME

1 The water makes the air rotate

The motion of the water makes the air rotate like a small tornado, sucking the curtain inwards. Known as the cyclone effect, it works in cold and warm showers.

2 Warm air moves upwards

Warm water from the shower head heats the air, which expands, moves upwards, and is located above the cold air.

3 Cold air makes the curtain blow inwards

Cold air moves under the shower curtain to replace the disappearing warm air. The pressure from the cold air boosts the curtain's motion into the shower booth.

4 An open door makes the phenomenon last

If the door is closed, all the air will be heated, making the air flow motion stop. But if the door is open, cold air will constantly move in, pushing the curtain.

WHY DOES A SHOWER CURTAIN STICK?

The shower curtain is sucked against us in the shower for two non-related reasons. As water flows out of the shower head, a vortex is produced, making the bottom of the curtain blow inwards. Warm water heats the surrounding air, and the upward-flowing air produces underpressure, making the shower come even closer.

CLAUDE LUNEAU

IN SHORT

DOES ALCOHOL DEHYDRATE YOU?

Your urine production is adjusted by the vasopressin hormone, which retains water in the body. Alcohol reduces vasopressin production, and the body excretes more urine, becoming dehydrated.

WHY IS MY INTERNET RADIO SIGNAL DELAYED?

The sound of Internet radios is sent as a flow of data packets from radio station servers via the Internet. The signal is delayed since it must be coded and decoded en route and move through cables and routers. The Internet radio stores some of the sound before it begins to play. An FM radio receives the radio waves directly.



TIVOLI AUDIO

NATURE IN PRACTICE

WHAT IS MORE DANGEROUS, SAND OR VOLCANIC ASH?

Sandstorms near the Sahara or other places may create problems for air traffic, as the large volume of sand in the air affects the engine parts and the windows. But volcanic ash is more dangerous than sand, as ash particles are sharp, and can ruin the engine faster.

Ash makes up altitude problem

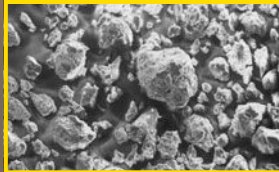
The volcano shoots ash up to an altitude of 10-15 km, where planes typically fly. The wind only lifts sand to an altitude of about 5 km, so sand only constitutes a problem during take-off and landing.

ARCHIVE

Ash cuts up the engine

Grains of sand are smoother and rounder, whereas ash particles are sharp and pointed. So, ash will cut up plane parts such as the engine faster than sand. Ash also contains abrasive volcanic glass, which affects the engine.

Sharp ash particles



Molten ash sticks to plane

Ash particles are abrasive and may stick to a plane, as the temperature of the engine is higher than ash's melting point of 800 degrees C. Grains of sand melt at 1,600 degrees C and are not as harmful to the engine.

Ash-blast plane engine



WHAT IS DENTAL FLOSS MADE OF?

Dental floss is made of one or more thin threads of nylon, which is a strong synthetic fibre. The thread is covered in wax, making it slide more easily between the teeth. Dental floss features a high tensile strength of more than 200 megapascals (MPa). In comparison, rubber band only has a tensile strength of 16 MPa. The first dental floss was made of silk, but after World War II, silk was out-competed by the stronger, more flexible nylon material.

SHUTTERSTOCK

IN SHORT

DOES OUR TASTE IN FOOD CHANGE?

Bitter food is often toxic — children know this instinctively. But with age, we learn that bitter food also contains important nutrients. The benefits are greater than the danger, so adults learn to eat bitter things, rat experiments demonstrate.

Did you know that the area of our small intestine is approximately 30 m²? The big surface is important in order for all nutrients to be absorbed.

Is it really true that insects aren't hurt by taking a long fall?

I have often flicked away insects such as beetles, making them fall several metres. But they do not seem to be harmed. Why is that?

A human being who falls from a window on the seventh floor will probably never get up again. If an insect takes a similar fall, it will not be harmed.

One of the most important reasons for insects' apparent invulnerability is that they are very different from mammals. Humans and other mammals have an internal bone skeleton with all the soft and vulnerable parts on the outside. Insects have an external skeleton, a so-called exoskeleton, with all the soft parts on the inside. The exoskeleton consists of an extremely hard material known as chitin, which is also much more flexible than human bone. So, chitin can more easily absorb the force of falling without breaking.

Arthropods such as spiders and woodlice grow by casting off their old exoskeletons. If a fall causes cracks in the chitin plates or a ripped off leg, arthropods are able to replace the damaged body part with a new limb the next time they "exuviate" or shed their skin.

Cockroaches hit the ground with much less force than people.



1. The skeleton

of an insect is external. The exoskeleton functions as an armour, protecting the soft organs.

2. A large surface

area means lower velocity. The smaller the animal, the bigger its typical surface as compared to its volume. A large surface means more air resistance, so the insect falls more slowly.

3. Low density

makes the landing softer. The lower the mass of an animal as compared to its surface area, the lower the force drawing it towards the ground. Humans land at a force of 20 kg/m², whereas an ant hits at some 200 g/m².

SPECIAL

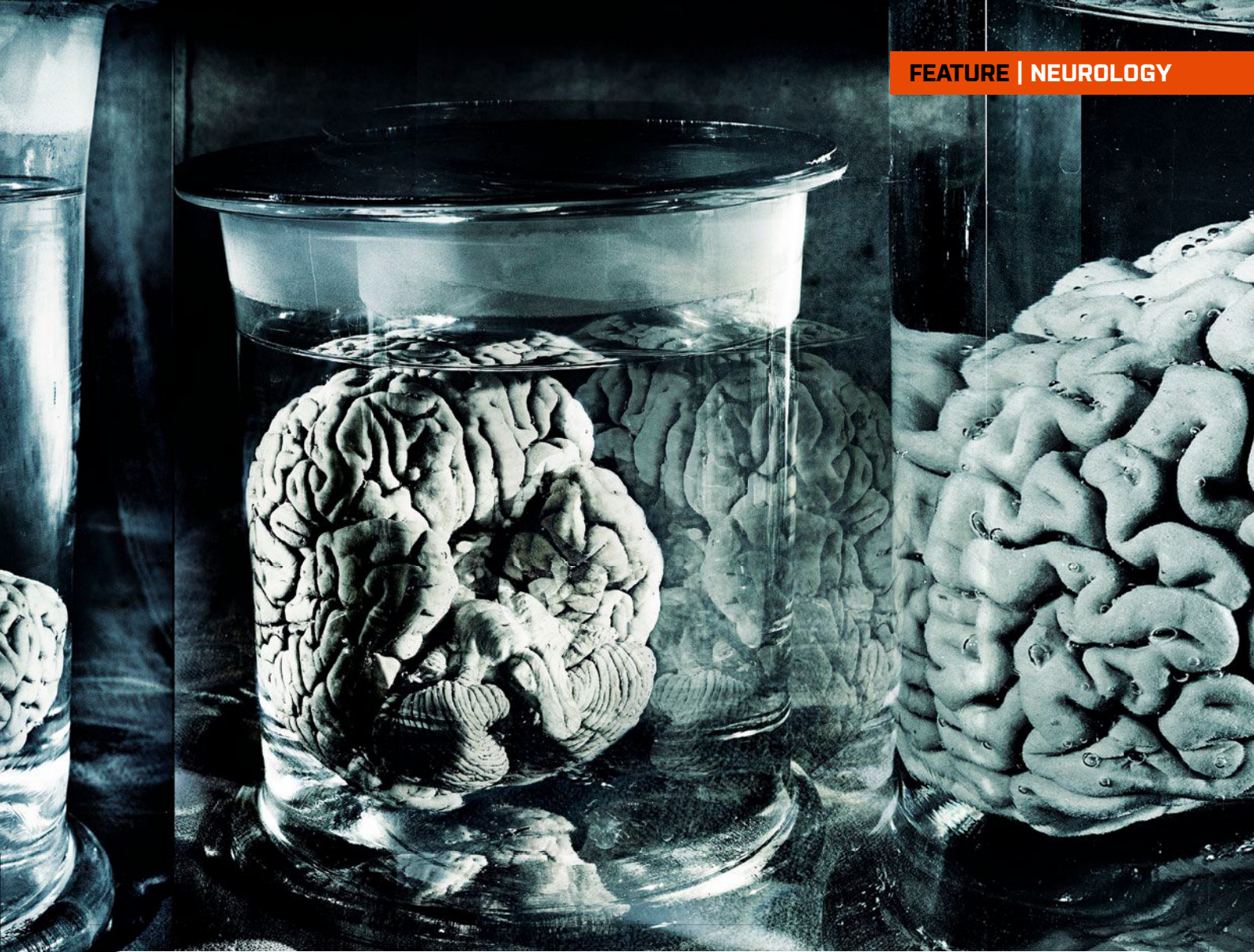
Our massive brain science issue is split into four parts:

- 1: Consciousness**
- 2: Intelligence**
- 3: Memory**
- 4: Sleep**

Chasing Down a Thought

By Gorm Palmgren

New sophisticated scanners have made an old dream come true for scientists – they have mapped out the hidden networks of the brain. The first glimpses of our subconscious have revealed how a thought develops into action and why thoughts can derail and become hallucinations.

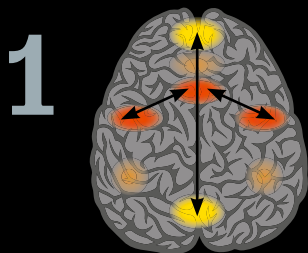


BREAKTHROUGH:

How the brain comes to life

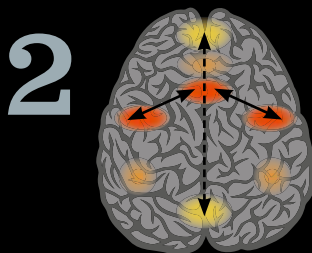
1. UNCONSCIOUS

When you are unfocused, your brain is in a state of unconsciousness. **The urgency network** monitors sensory impressions, but it has not detected anything important and so does not stimulate the **default mode network**.



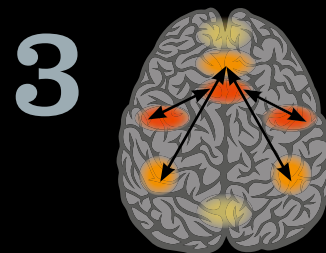
2. HALF CONSCIOUS

Suddenly, a bird hits your window. **The urgency network** registers the sound, putting a damper on **the default mode network**, so it runs more slowly and wakes you up from your daydreaming.



3. CONSCIOUS

The bird breaks the window. **The urgency network** registers the visual impression, turning off the signals to the default mode network and making you focus. **The task-positive network** is stimulated. You are ready to act.



Three networks control your mind

THE DEFAULT MODE NETWORK is the basic state of the brain. We are absent-minded, unfocused, daydreaming.

THE TASK-POSITIVE NETWORK is activated when we need to respond to the outside world and do particular things.

THE URGENCY NETWORK monitors the visual impressions and reacts if something happens which we need to respond to.

Your boss would probably not be amused, if you told him that only 1.5 of your working hours are spent on today's tasks while you spend the rest of the time daydreaming. But your boss might as well get used to the idea, as she is not one bit more focused herself.

The brain is so fond of chit-chatting with itself that it spends 80% of its activity on daydreaming, leaving only 20 % for real work such as reading a book or writing a note.

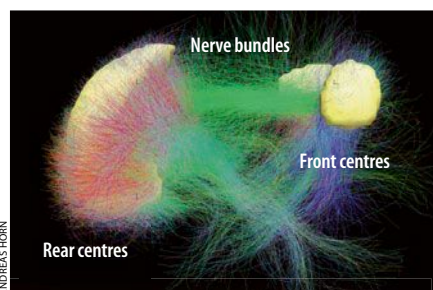
Radiology professor Van Jay Wedeen has used a sophisticated scan method to observe the motion of water molecules along individual neurons of the brain. The brain researcher from Massachusetts General Hospital in Boston, USA, watched thoughts "flow" through the billions of nerve paths of the brain and change path when his test subjects shifted their attention from one thing to another.

Van Jay Wedeen's scans are the most recent of a long series of scientific projects, which have mapped out the connecting roads of the brain in recent years. The projects have revealed that cerebral centres cooperate in three main networks, which are constantly active in separate circles. So, scientists are closer than ever to understanding one of the fundamental

characteristics of humans: our consciousness about ourselves and the world surrounding us.

BRAIN IN DEFAULT MODE

The consciousness is the human window to the outside world. Here, we realise emotions, thoughts, and sense impressions, so we can respond to them and make decisions. But it



The busiest place in the brain is the default mode network, where two nerve bundles link four cerebral centres.

is not a window providing us with very much outlook, as the consciousness only reveals a small part of the world to us. A fly may be buzzing around, but we are only aware of it, when it lands on our arm.

A few decades ago, scientists believed that the brain was shut down and relaxed,

when it did not take care of any concrete tasks. Brain scans did reveal a type of activity in any situation, but the variation was explained as noise in the meters. That was utterly wrong.

Today, scientists know that our brain operates in five networks. Two small networks constantly monitor vision and hearing, whereas the bigger urgency network monitors all stimulus and evaluates if something requires action. If so, the big task-positive network is activated, telling all relevant cerebral centres to carry out the action. But most of the time, the brain is busy daydreaming in the so-called default mode network.

At the Washington University School of Medicine, brain researcher Marcus Raichle has spent 20 years trying to find out what the brain is doing when we are inactive. In 2001, he identified the default mode network, which links the cerebral centres for memory, reflection, and empathy. When the network is active, we are unfocused and doing nothing in particular. But lots of unstructured ideas fill our heads.

In spite of the low activity level, the network is responsible for 80% of the brain's energy consumption. So, several scientists have taken up the thread, investigating what the brain is doing, when the default mode network is active.

One of them is Andreas Horn of the Max Planck Institute in Berlin, Germany. In 2013, he scanned 19 adult test subjects to find the most active cerebral centres, using Wedeen's method to find the connecting pathways. The experiment revealed that the information flow was concentrated in two thick bundles of neurons in each cerebral hemisphere. The two nerve bundles are among the brain's busiest nerve paths and linked with two centres at the front and back of the brain.

Soccer activates all networks

In a soccer match, your brain will constantly shift between different levels of consciousness, turning three three networks on and off.

SHUTTERSTOCK



The urgency network

has reduced the signals to the default mode network, so the goalkeeper is ready to throw himself at the ball.



The task-positive network

is fully activated, so the soccer player avoids the goalkeeper and scores.



The default mode network

is on standby, so the soccer player can focus on taking the right shot.

SCIENTISTS MAP OUT THE MOTION OF A THOUGHT

In recent years, scientists have mapped out the activity in the five networks, observing the motion of a thought through the nerve paths of the brain when we take conscious action. ►

CONSCIOUS

Impressions constantly flow through the brain, but only a fraction reach the conscious mind.

You notice one in a million

The retina of the eye constantly registers impressions, but only one in a million reach the conscious mind. Brain scans have shown that we become more aware of a visual impression if it is processed at the front of the brain.

SPL/GETTY IMAGES

Neurons involved in conscious visual impression processing



10-20 %
The primary visual centres produce a rough picture of what you see. 10-20 % of the brain activity is conscious.

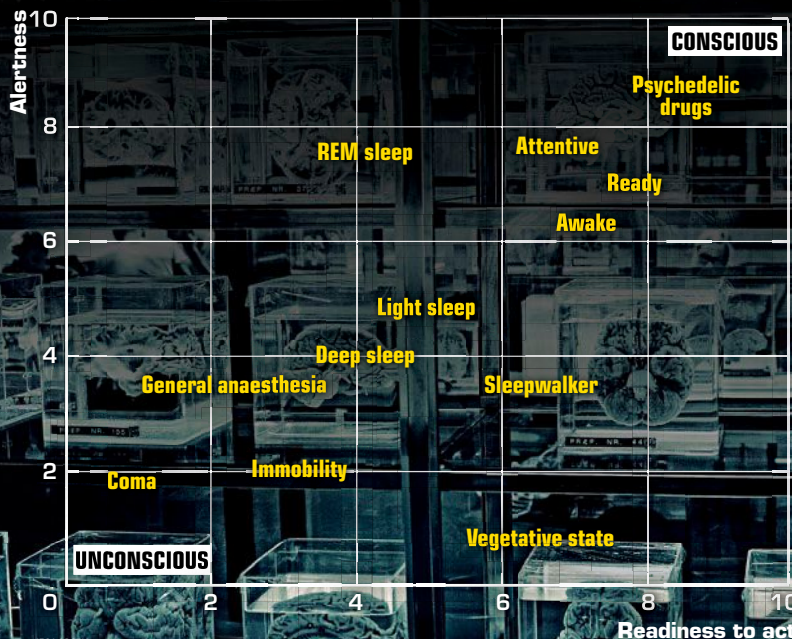
20-50 %
A detailed image appears, and you realise the visual impression. 20-50 % of the brain activity is conscious.

50+ %
The visual impression has been processed and understood, so you can act. At this point, 50+ % of the brain activity is conscious.

The more detailed the image, the further to the front of the brain, and the more conscious we become.

Drugs expand your world

Psychedelic drugs such as LSD make the default mode network run wild and stop cooperating with the other networks. This will sharpen your senses and stress out the body, so you feel 100% conscious.



FAST FACTS

CONSCIOUSNESS DEVELOPS FOR 25 YEARS

The conscious mind develops over time, as the cerebral networks become more complex. The networks are fully developed at the age of 25. This explains why children become more aware as they grow up.

Six objects

are what the brain is aware of at a time. At the very moment you see a beautiful landscape in the autumn, you are only conscious of for instance the field, the trees at one side, the blue sky, the fleecy clouds, and the tractor. You only notice the plough when you start wondering what the farmer is doing this time of year.

0.5 second

is how long the conscious lags behind reality. If you burn your fingers on a cooking plate, you will take 0.5 second to notice. But to limit trauma, the body reacts automatically after just 0.35 seconds, removing the hand.

► At Stanford University in the United States, brain researcher Vinod Menon has carried out several experiments to study the connection between the default mode network, the urgency network, and the task-positive network.

First, the scientist scanned the test subjects' brains while they were relaxed, sitting down with their eyes closed. In this case, the default mode and urgency networks were very active, whereas the task-positive network was not.

Subsequently, Vinod Menon made the test subjects listen to classical music, which suddenly changed in nature. The urgency network immediately registered the change, reducing the signal to the default mode network and hence its activity level, and the subjects were awakened from their daydreams. But as the music did not require any action on the part of the subjects, the activity level of the task-positive network remained low.

In the third experiment, Menon made coloured discs appear on a computer screen two seconds apart. When the disc was green, the test subjects were not supposed to do

anything, but every 20th time, when it was blue, the subjects were to hit a button. The urgency network reacted strongly to the blue disc by ending the nerve signals to the default mode network, which stopped. Instead, the nerve signals were sent to the task-positive network, which was activated, so the subject was fully focused and able to carry out the action required.

SCATTERED CONSCIOUSNESS

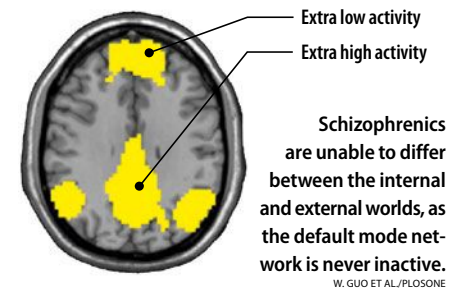
The experiments have shown how we become aware, but exactly where the consciousness is located remains a mystery.

The vision network is located at the back of the brain and normally functions as part of our subconscious. So, we are not aware of the fly we spot out of the corner of our eye, unless the urgency network makes us aware of it (perhaps by its annoying buzz). If so, the vision centre's first, rough impression will gradually be sent further and further towards the front of the brain, where it is analysed and makes sense, so we can chase the fly away.

The process in which a visual impression goes from being unconscious to having our full attention has been studied by many

scientists over time, and Melanie Boly from the US University of Wisconsin compared all the results, concluding in 2013 that the closer to the front of the brain a visual impression is, the more conscious we are about what we're actually looking at.

When the visual impression is processed at the back of the brain, only around 15% of the brain activity is conscious. When it



passes to the central part of the brain, the impression has turned into a meaningful image, and about 35% of the brain activity is conscious. When the frontal lobes at the front of the brain finally analyse the image and react with an action, as much as 50% of the brain activity is conscious.

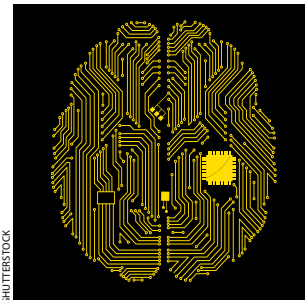
IN THE FUTURE:

Artificial brain copies humans

1, 2, 3 - 5, 6, 7 - 3, 4, ?

Which number replaces the question mark?

This problem is easy to solve for a human being, but it is a huge challenge for an artificial brain that copies the way in which the human brain works. In 2012, Chris Eliasmith from the University of Waterloo in Canada built the artificial brain Spaun, which is the best copy of our own brain so far. Though the brain only has 2.5 million neurons – just 0.003 %



of the human brain's – it functions in almost the same way. At this point, Spaun is only able to recognise the numbers 1-10 and solve simple problems.

The artificial brain Spaun demonstrates how our brains work.

Melanie Boly's studies show that consciousness is not located in one single region, but rather it is scattered across the front of the brain.

NETWORK ERROR MAKES BRAIN SICK

This insight into thought motion has provided doctors with new explanations of diseases such as schizophrenia, depression, ADHD, and Alzheimer's. The four disorders disturb the default mode network, as the brain is stuck in the standby mode and cannot start new jobs.

Normally, the activity in the default mode network is the opposite of the task-positive network - one shuts down, as the other one is activated. So the brain easily shifts from an internal, unfocused world to an external, focused world. People who suffer from ADHD find it hard to focus. According to several studies, this has to do with their default mode networks not functioning as they should.

In a study from 2014, Laurent Querne from the CHU Amiens university hospital in France scanned 22 children, as they focused on the direction in which one of many arrows pointed. Half of the children suffered from ADHD, and their scans showed that the default mode network did not shut down, as they pointed out the direction of the arrow, and the task-positive network took over. The children also took longer to determine the direction. This may be due to the brain not focusing all its resources on the task-positive network while the default mode network was still active. The results of the study became even more convincing, when Querne demonstrated that the drug Ritalin, which is used to treat ADHD, restores the balance between the default mode and the task-positive networks.

In 2014, a similar study by Wenbin Guo from the Guangxi Medical University in China showed that schizophrenia can also be explained by a default mode network error. Brain scans revealed that compared to healthy people, the schizophrenic patients showed very high activity in the rear area of the default mode network, and very low activity in the frontal lobes. The error means that it is difficult for schizophrenics to distinguish between the internal and external worlds, which in some cases may cause auditory or visual hallucinations.

The next step is to find out how to correct these brain errors, so all mentally ill patients can control their own minds. **SCI**

Unlock the hidden corners of your brain

If you want to expand your mind, you must use your senses and be more conscious when you use your vision, hearing, etc. These small exercises make a good start.

JES LARSEN & SHUTTERSTOCK

USE YOUR
GREY CELLS!



Categorise your impressions

According to many scientists, the mind can only hold five or six objects at a time, so unless you use special tricks to assist your memory, it can be difficult to remember any more. One trick is categorising colours or types.

VISION EXERCISE:

Look at the image for 30 seconds. Put it away and count the objects you remember.



OTHER WAYS...

Separate sounds

Your senses are the foundation of your consciousness, but often, we are not sufficiently focused, missing lots of details. That is not only true for vision, but for the other senses such as hearing.

HEARING

EXERCISE: Listen to a piece of classical music and focus on individual instruments such as the violins and observe their contribution to the music.

Focus on nuances

When you eat, you may do it fast, only thinking about whether it tastes good or bad. Like any other sense, it is also possible to sharpen your attention by separating the taste impressions.

TASTE

EXERCISE: Describe the different tastes of your food. Focus on the acid, sweet, and aromatic components contributing to the overall impression.

SPECIAL

Do you even know how smart
you could potentially be?

- 1: Consciousness
- 2: Intelligence
- 3: Memory
- 4: Sleep

Scientists Search for the Genius Gene...

By Gorm Palmgren

Good genes. That may be the only difference between a genius and an idiot. For years, brain researchers have been looking for the exact place in our DNA that makes some people smarter than others. Now, they may have finally found the difference in our myriad genes.

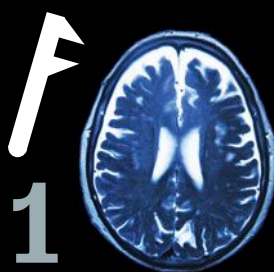
BREAKTHROUGH:

Thick brain... smarter you?

In 2014, scientists discovered a gene that links the neurons of the cerebral cortex. The gene produces a branched network, which makes the cerebral cortex thicker, so it can carry out complex nerve signal processing. Normally, the gene is an IQ booster, but a few people have a special variant, which makes the cerebral cortex thin and IQ low.

1. Cerebral Cortex Thickness

Scientists made MRI scans of the brains of 1,583 14-year-olds, measuring the thickness of the cerebral cortex in 33 places of the brain.



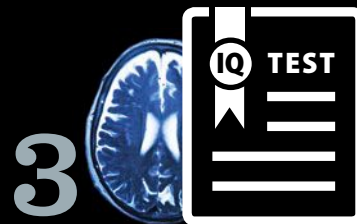
2. Genetic fix points

From each teen, scientists extracted and analysed DNA. Thousands of genetic fix points were compared to the thickness of the cerebral cortex. One, a variant of the NPTN gene, produced a thin cerebral cortex in the left cerebral hemisphere.



3. IQ test

The teens took an IQ test, and their school grades were analysed. The scientists discovered a close relationship between low IQ and the special variant of the NPTN gene, which produced a thin cerebral cortex in the left hemisphere.



Clear your mind. Now imagine you are in a bar. A farmer comes in, bragging about his animals. He has horses, cows, and sheep. A total of 187. He has three times as many horses and seven times as many cows as sheep, he says. Whether you can figure out how many horses, cows, and sheep the farmer has depends on who your parents are.

For years, brain researchers have tried to find the genius gene - the slight physical difference that makes some brains more intelligent than others. But over this past year, scientists have become ever more

convinced that the answer is in the genes. Scientists have not only discovered the gene that makes the cerebral cortex grow, they have also spotted the genes that convert the information flow from a slow main road into a fast motorway.

WE ARE SMARTER THAN OUR ANCESTORS

The search for the genius gene began in the early 1900s, when English psychologist Charles Spearman discovered that all intelligent people seem have one thing in common: G or general intelligence.

Today, scientists still do not know exactly

what G is. According to some, G means faster nerve signals. Others are convinced that G is a type of command centre in the brain. Yet others believe that it refers to particularly efficient motorways for nerve signals moving between cerebral centres. But take note: no matter what, G is *not* IQ.

While IQ measures current intelligence (albeit in a limited way), G expresses the brain's potential. It's how smart you can *become*. You may have a low IQ and a high G. But if you have a low G, the brain's potential is limited, and you probably also have low IQ.

The whole concept of IQ has been criticised because it focuses on certain types of intelligence.

If you are good at maths, logical puzzles, rotating 3D objects in your imagination and a few other rather abstract things, you will probably score quite well in an IQ test.

But if you are bad at maths but write amazing poetry or paint beautiful pictures, you may not have that high an IQ... at least according to the test.

Yet people who can do square roots in their head or understand complex economic theory may struggle to draw even a basic cartoon. Does this mean they are dumb?

And what of people who are extremely skilled at social interaction? Some people have very advanced so-called "soft skills" - the ability to intuitively see social conflict and solve it with just the right words at the right moments. This is clearly a kind of high intelligence, but an IQ test can't spot it.

The definition of intelligence might be tricky, but scientists recently made real, substantial progress in the search for the ever elusive genius gene. ▶

Twins confirm importance of genes

When scientists study the influence of genes on intelligence, they often use twins, as they grow up together and are either genetically very similar (fraternal) or virtually identical (identical twins). It's nature vs nurture.

IDENTICAL twins grow up together

Genetic similarity: 100 %

Environmental similarity: High

Very little difference of IQ.

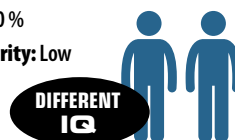


IDENTICAL twins grow up apart

Genetic similarity: 100 %

Environmental similarity: Low

Difference is due to nurture.



FRATERNAL twins grow up together

Genetic similarity: 50 %

Environmental similarity: High

Difference is due to nature.

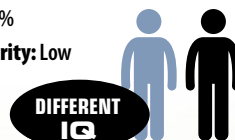


FRATERNAL twins grow up apart

Genetic similarity: 50 %

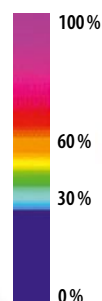
Environmental similarity: Low

Difference is due to nature and nurture.



Twins in a similar frame of mind

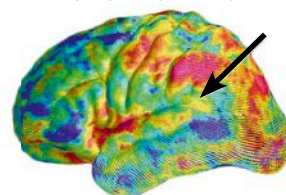
Twin brains are very much alike. The colour scale indicates the degree of similarity.



IDENTICAL TWINS



NON-IDENTICAL TWINS



INTELLIGENCE

The physical structure of your brain determines how intelligent you may become.

Your brain is like a computer

The brain regions perform different tasks just like a computer. Three functions are particularly important for intelligence.

Processor

The cerebral cortex is the outer layer of the brain and consists of grey matter. This region processes all data and may be compared to a computer processor.

Power: The thicker the grey matter of the cerebral cortex, the more data the brain can process, and the easier it is to complete a task quickly.

Data bus

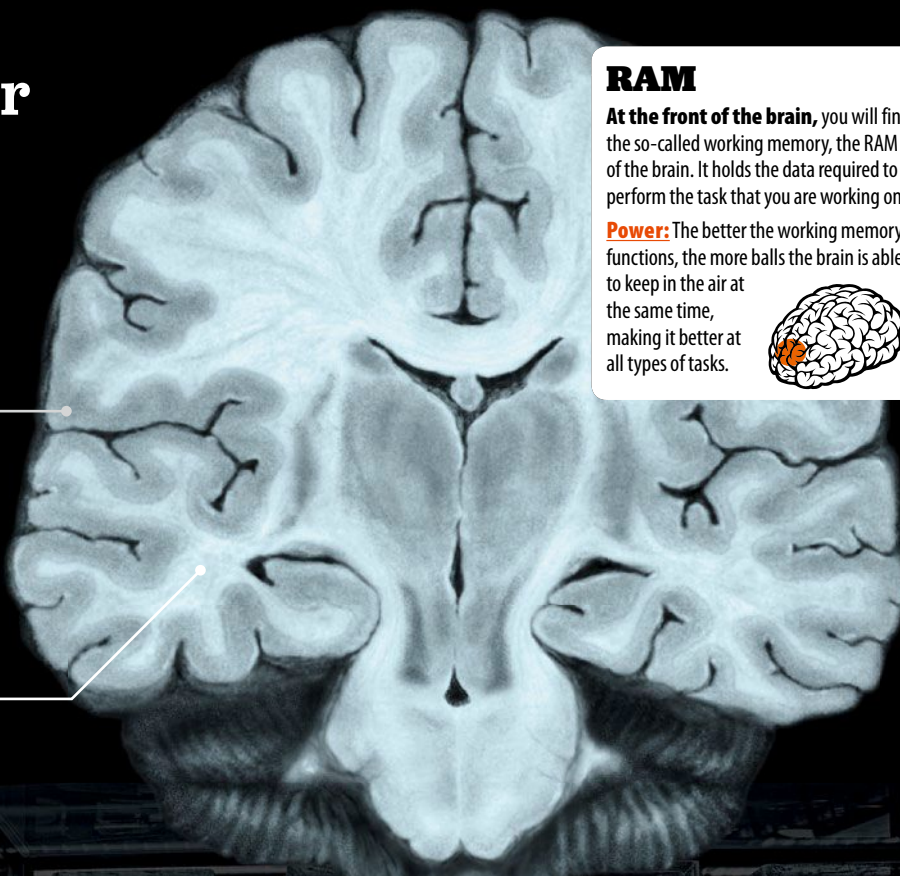
Inside the brain, you will find the white matter, where all communication between cerebral centres takes place. It is equivalent to a data 'bus' or circuit.

Power: The larger the network in the white matter, the more efficiently the cerebral centres can exchange information and perform their tasks.

RAM

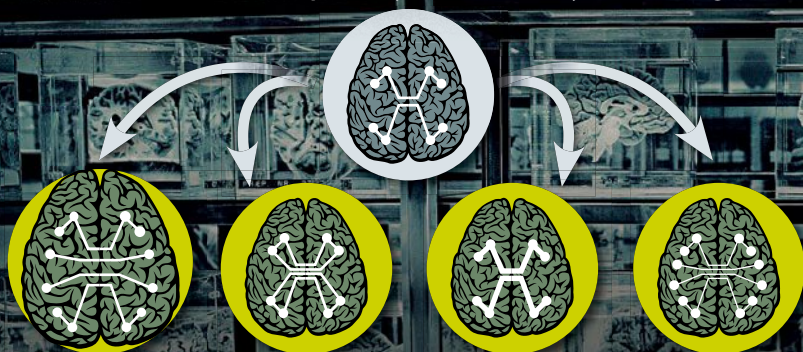
At the front of the brain, you will find the so-called working memory, the RAM of the brain. It holds the data required to perform the task that you are working on.

Power: The better the working memory functions, the more balls the brain is able to keep in the air at the same time, making it better at all types of tasks.



Have humans evolved peak intelligence?

In the future, the human brain could develop in four directions. No matter which, we will probably not become any more intelligent.



1. Bigger brain

The brain will have room for more neurons, so its processing power is increased.

Drawback: Signals travel longer distances, so the brain's processing **speed** is reduced.

2. Denser network

The cerebral centres get more links, making them cooperate faster.

Drawback: All the nerve links take up more space, and the brain needs more **energy**.

3. Thicker neurons

Nerve signals travel faster, so the centres communicate more efficiently.

Drawback: Thick neurons consume more energy and take up **more space**, so the brain gets bigger.

4. Thinner neurons

The neurons can be packed more densely, so the brain has room for more.

Drawback: The ion channels are packed too densely and more exposed to nerve **signal noise**.

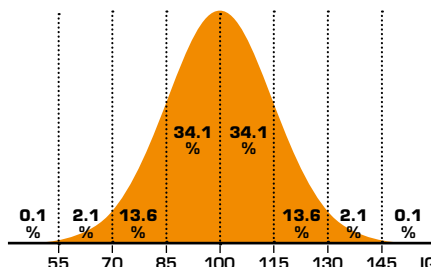
FAST FACTS

7 points

That is how much higher IQ eight-year-old children, who were breast-fed for at least one month after birth, have in comparison with bottle-fed kids. This is probably due to breast milk fat, which protects brain neurons.

THE AVERAGE IQ IS 100

The IQ scale is designed with an average of 100 and a normal IQ of 90-110. In a military service examination, boxer Muhammad Ali's IQ was determined to be just 78. This clearly underestimates the capability of a fast, tactical thinker with an innate flair for self-promotion!



► Two scientists from King's College London (not to be confused with Cambridge!), Maciej Trzaskowski and Robert Plomin, have found new ways and used the improvements of genetic analysis methods of recent years.

In an experiment, scientists took blood samples from 2,875 children and mapped out 1.7 million genetic fix points in their chromosomes. They compared the results with IQ tests that the kids had taken at the ages of seven and 12. The analyses indicated a close relation between IQ and some of the genetic variants, which consequently had to be involved in IQ inheritance. The studies also showed that the importance of the genes increased with age. In seven-year-old children, the genes only explain 26% of the IQ, but five years later, their importance had increased to 45%.

Intelligence can, in some ways, be compared to a computer. The hardware is the physical characteristics such as cerebral cortex and nerve paths, whereas the software is the challenges that the brain is working with. When people are young, the problems are easy, so the genetic potential, G, is not fully challenged – like a supercomputer running a simple word processing programme. As more demanding software is installed, such as video editing or an accountancy package, the computer reveals its potential.

When children grow older and are introduced to more difficult problems, the cerebral structure and nerve paths are more important. So, the importance of the

genetics increases with age, and some studies show that in adulthood, genes account for 80% of intelligence.

GENES MAKE THE BRAIN GROW

At King's College London, some of the two scientists' colleagues have taken up the challenge, and are seeking to identify the genes that influence intelligence.

Brain researcher Sylvane Desrivieres carried out DNA analyses of 1583 teenagers, who had taken an IQ test. Then, she measured the thickness of their cerebral cortexes using brain-scanning equipment. The results, which were published in 2014, showed that the least intelligent children had a special variant of the NPTN gene and

slightly thinner brain cortexes in the left cerebral hemisphere. The cerebral cortex is the part of the brain in which neurons link up with each other, and it can be compared with the CPU of a computer, which carries out all complex calculations. In children with thin cerebral cortexes, the brain has less mathematical calculating power.

Next, Sylvane Desrivieres examined the NPTN gene. Her studies showed that the gene usually makes the cerebral cortex grow, enabling it to carry out complex processing of nerve signals. In the special variant in the least intelligent children, the gene lost its effect in the left cerebral hemisphere, so the cerebral cortex became thin.

MOTORWAYS IMPROVE IQ

However, there are strong indications that there is more than one "genius gene" when it comes to brain development. At the very least, the NPTN gene is not the only part of a person's DNA that affects intelligence. Brain researcher Rachel Brouwer discovered that other genes stimulate the growth of the white matter and the cerebellum.

The white matter hides beneath the surface of the brain, and links the different regions. In our computer metaphor, white matter can be compared to the circuits that move data back and forth between units – the so-called "bus". A computer cannot use a powerful processor optimally if the hard drive is slow, and likewise, a well-functioning brain depends on both grey and white

“

Among mathematically gifted children, scans show very busy nerve paths between the centres responsible for decisions based on scientific reason and creative thinking.



IN THE FUTURE:

Will our intelligence fall?

Teachers will have a tough job in the future. According to a British scientist, the children of the West will become increasingly stupid.

Many intelligent women are so busy with their careers and their lives that they choose not to have kids.

According to studies made in 2014 by

brain researcher Satoshi Kanazawa, each time a woman's IQ increases by 15 points, the likelihood that she will ever have children decreases by 25 %.

Consequently, future generations of children will have mothers with relatively low IQs. And as intelligence is highly

hereditary and believed to be mostly inherited from the mother, the general intelligence in society may just deteriorate.

Children's IQ may fall, as smart women have fewer children.



USE YOUR
GREY CELLS!



Improve your G - right now!

You can try to increase the potential of your brain - G, your general intelligence - by improving your "working memory". Try the following three exercises...

JES LARSEN & SHUTTERSTOCK

matter. Made at the Utrecht University Medical Centre in Holladn, Rachel Brouwer's analyses showed that the genes did not only spur growth, they also made the brain function more efficiently, giving its owner a higher IQ. One of Brouwer's most interesting discoveries was that the volume of the white matter is hereditary - and it also influences IQ.

Since then, several other scientists have studied the white matter using a new, sophisticated scan technology, which lets them map the brain path network.

One of these is Spanish scientist Francisco Navas-Sánchez. In 2014, he compared the networks of two groups of children, one with an average IQ, and one with exceptional mathematical skills. The more "math smart" the children were, the stronger the networks produced by the white matter between the two cerebral hemispheres. But among the mathematically gifted children, the scans also showed very busy nerve paths between the centres responsible for decisions based on reason and creative thinking. This combination apparently results in gifts mathematical ability.

PRACTICE IMPROVES YOUR POTENTIAL

You can undoubtedly increase your IQ, but scientists still disagree whether you can improve your general intelligence, or G.

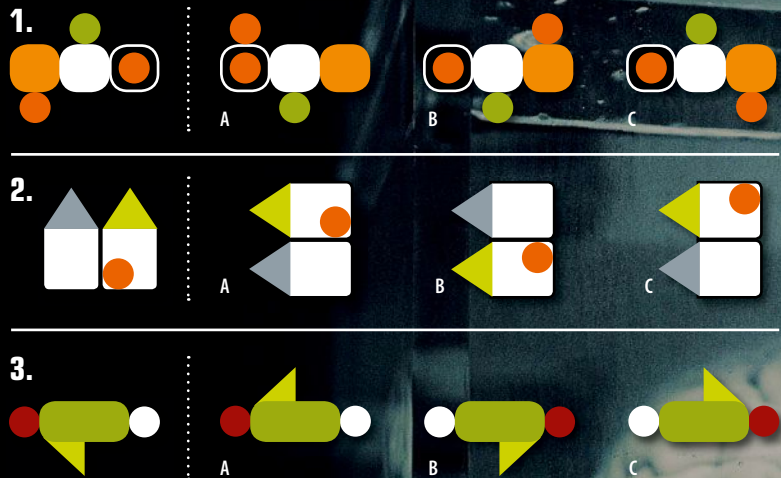
Brain researcher Susanne Jaeggi is convinced that you can improve G by strengthening your working memory. The working memory is that small, passing memory which only includes what we are working with at the moment. In an experiment, Jaeggi tried to improve the working memories of test subjects with an exercise, in which they had to remember if they had seen a certain letter a few moments ago. After a month, the subjects had improved their working memory and become better at remembering the letter. Then, they took an ordinary IQ test and, surprisingly, scored five points more than they had before the exercises! As the exercise did not provide relevant knowledge for the IQ test, Jaeggi concluded that it had improved G.

Oh, remember the bar and the guys with the sheep? Well, with the right kind of IQ, you might have calculated that the farmer has 17 sheep, 51 horses, and 119 cows. Big woop. **SCI**

Rotate this object in your head

When you put together a jigsaw puzzle, you often decide whether a piece fits in by rotating it into the right position inside your head. This puts considerable demand on your "working memory". Practice with this exercise or a real puzzle.

EXERCISE: In each row, rotate the figure to the left inside your head and decide which of the three other figures it corresponds to.



OTHER WAYS TO GET SMART...

Remember the card

Your working memory can also be exercised using playing cards. Flip the top card, try to memorise it, and place it with the reverse side up, and flip the next card. Continue until the card you just flipped has the same value - for instance a six.

EXERCISE: Now make the practice more difficult: The card you are looking for must have the same value as the card you flipped two flips ago. Then increase the distance between the two cards (3 flips, 4 flips etc).



Find the connection

In this exercise, you must find the connection between three figures and determine figure No. 4 based on your logic.

EXERCISE: Take a good look at the squares. Which is the next in line?



Answers: Problem 1: B. Problem 2: A. Problem 3: C. In connection with the last problem, the red and the white areas move clockwise. The striped ones move counter-clockwise, and each field rotates 90 degrees.

SPECIAL

Would you be brave enough
to mess with your memory?

- 1: Consciousness
- 2: Intelligence
- 3: Memory
- 4: Sleep

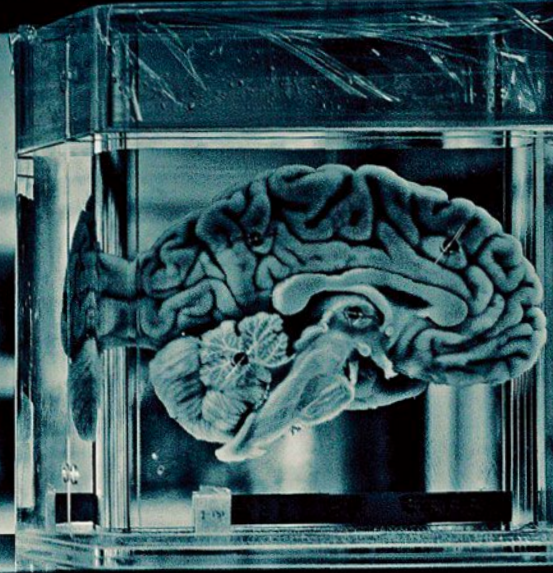
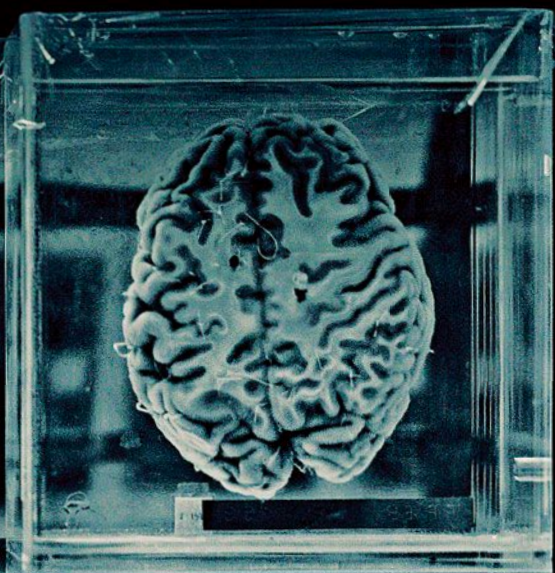
Scientists Could Soon Erase Your Memories

By Gorm Palmgren

We are very bad at remembering. Our brains edit our memories all the time and fill in gaps with events that never happened.

Thanks to a new, sophisticated type of genetic engineering, scientists can now manipulate our memories and erase recollections.

JES LARSEN

**BREAKTHROUGH:**

False memories overwrite reality

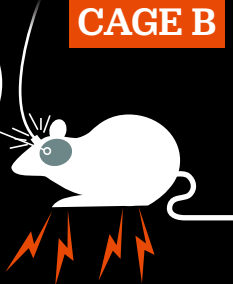
By means of sophisticated genetic engineering, brain researchers have planted a false memory in a mouse brain. The method makes the neurons that store specific experiences light-sensitive. When scientists illuminate the brain, the mouse remembers. If the recollection is retrieved, as the mouse experiences something new, the two are linked.

1. BRAIN BECOMES LIGHT-SENSITIVE

Scientists genetically modify neurons in the mouse's brain, which it uses to store the memory of a pleasant cage. The neurons become light-sensitive, so the mouse retrieves the memory, when it is exposed to light.

**CAGE A****1****2. MOUSE GETS ELECTRIC SHOCKS**

The mouse is moved to a new cage, and the scientists activate the new memory by means of light. At the same time, the mouse gets electric shocks in its feet. The mouse generates a false memory of electric shocks in the pleasant cage.

**CAGE B****2****3. PERMANENT FALSE MEMORY**

Back in the pleasant cage, the mouse immediately flinches. The false memory has become permanent, and in the future, the mouse will always associate the pleasant cage with electric shocks in the feet.

**CAGE A****3**

You are 12 years old. The sand warms your feet, and you hear the sound of waves. You are spending your summer holiday in Portugal. Suddenly, somebody screams. A rubber dinghy with a child is moving away from the coast. Your father determinedly jumps in the water and starts to swim at a rapid pace. He rescues the dinghy and the kid. Everybody cheers, and for the rest of the holiday, you are offered free food and drink in all restaurants of the small town.

This may be how you remember your holiday. But probably, half of it is wrong. Your memory is under constant reconstruction. In the process, the brain not only erases and distorts your memories; it also adds things that never happened.

Now, scientists can copy the brain and erase memories, using a new method.

MEMORIES STORED IN BITS

When you retrieve the memory about the trip to the beach, you put almost all of your brain

to work. The sound of the waves is an echo in the auditory centre, the rubber dinghy was stored in the visual centre, and your pride concerning your dad is located in the centre of emotions. In other words, the memory is stored in bits throughout the brain, and so, it is very difficult to erase it altogether.

The place in which your holiday recollection is stored is known as long-term memory. Unlike short-term memory, which stores a recollection for some 30 seconds, the long-term memory stores it for good.

Experiments have shown that long-term memory stores memories in a branched network of nerve links. The network is established the first time we experience something new, and it changes as new information is added.

You have learned that the Portuguese town, in which you spent your holiday, was named Estoril. The image of the town is a network in the visual centre, whereas the fact that the town is in Portugal is stored as a network in the temporal lobes right above the ears. The two networks are linked by yet

another network. If you talk about Estoril later, the entire circuit is activated, you immediately imagine the town, and remember that it is in Portugal. When you learn that the town has 26,000 inhabitants, the brain generates yet another network, which automatically links to the big Estoril circuit.

ONE GENE WORKS TO CONSOLIDATE MEMORIES

The new nerve links that store the memories must be built physically in the brain. The process takes up to a couple of days, and until then, the recollection is not solidly anchored in long-term memory. At the Massachusetts Institute of Technology (MIT) in the US, genetically modified mice have shown that one particular gene plays a decisive role in the building of your memory.

In an experiment, scientist Yingxi Lin and colleagues discovered that the *Npas4* gene was activated in the brains of mice right after they learned something new.

The scientists then studied what happened if the gene was deactivated. The mice's memories were subjected to a classic test, in which a particular sound would warn them of an electric shock coming up a few seconds later. The sound allows the mice time to prepare for the discomfort. But without the gene, the mice did not link the sound and the shock, leaving them unprepared. When the scientists reactivated the gene, the mice reacted.

According to the scientists, the *Npas4* gene controls the development of new networks and so it is key in the formation of new memories. The gene is particularly related to a region called the hippocampus, which is located deep inside the brain. Scientists used to think that memories were stored in the region, but now, they believe that the hippocampus functions as a hub, uniting all the individual parts of the memory from the visual or audio centres, etc.

Studies of people with damaged hippocampi indicate that this region of the brain is especially important for the formation of new memories and that the recollections can pass from short to long-term memory.

LOST IN YOUR BRAIN

So, long-term memory is a physical nerve track in the brain. Short-term memory only exists for those few seconds that the nerve signals are active.

When we hear something new, ►

1-2-3: A neuron becomes light-sensitive

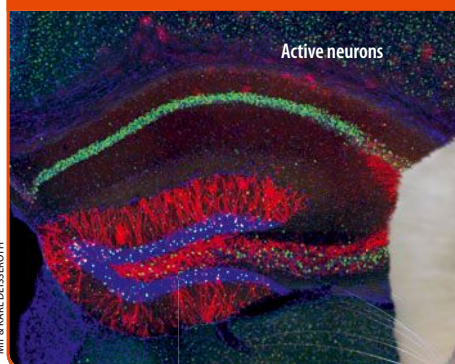
The light-sensitive neurons that scientists used to erase memories were created by means of a sophisticated type of genetic engineering.

1. Scientists find a light-sensitive protein, which reacts to coloured light.
2. The gene related to the protein is found and isolated.
3. The gene is inserted into brain neurons.
4. As scientists illuminate the brain with coloured light, the neuron is activated.



5. Scientists can now activate and deactivate the neuron.

Scans reveal luminous neurons



MIT & KARL DEISENROTH

MEMORY

Your memory is under constant reconstruction, and existing memories are distorted and erased.

Your memories are scattered across the brain

Human memory is made up of different storage zones that each hold different types of recollections. Short-term memory only stores information for 30 seconds, whereas long-term memory stores your recollections for good.

- Short-term memory
- Long-term memory



The phonemic loop

briefly retains the words we hear and read, or a new idea that pops up in our heads, by repeating them as an inner voice.

The episodic memory

stores incidents we have experienced, or things we have done. This is where our personal experiences such as childhood memories are stored.

The semantic memory

holds all the tangible, factual things we know, such as that snow is cold and white, that the chemical formula of water is H₂O, and the names of family.

The visual drawing board

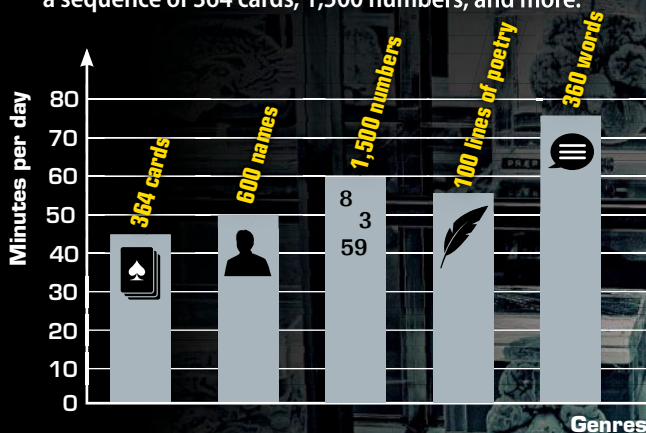
briefly retains new visual impressions of for instance the face of a stranger by projecting the image over and over again inside our heads.

The procedural memory

holds the knowledge we make use of without thinking about it, such as when we tie our shoelaces, play the piano, or ride a bicycle.

Memorising 1,500 numbers a day

Memory athlete Nelson Dellis practices for four hours and 45 minutes a day. During that time, he memorises a sequence of 364 cards, 1,500 numbers, and more.



FAST FACTS

4 yrs

is the earliest age from which most people have memories. According to scientists, young children store their memories, but the earliest ones are erased at the age of 10. But people who had dramatic experiences at the age of down to 2 can often remember it as adults.

30 days

after travelling, jetlag may impair your memory, hamster experiments show. The cells of the hippocampus, which are important for memory, divided 50% slower in jetlagged animals, which were 3 times as bad at remembering the location of treats.

► such as that Estoril is in Portugal, short-term memory holds on to the data by an inner voice repeating it over and over again. This goes on for 30 seconds, after which the signals burn out. If the brain does not intervene, passing the memory on to the long-term memory, it is lost.

So, short-term memory makes sure that we do not forget the beginning of a sentence before we finish it. But when the whole sentence has been read, its destiny depends on whether long-term memory adopts it.

When a recollection passes from the short-term memory, it becomes permanent and cannot easily be erased. If you forget in what year you were in Portugal, the memory is still in your brain - you just cannot find it.

UNSTABLE MEMORY

Indeed, your memories are lasting, but in no way stable. One of the most important qualities of your memory is that recollections are unstable and can be edited. If you drink a glass of vinegar, it makes sense to be able to remember it for a long time (and will avoid drinking vinegar in the future). But if you drink a glass of sour milk by mistake, it is not

“

Our heads are full of false memories of experiences that we imagine or hear about from others.

expedient to remember it. The next time you enjoy a glass of fresh milk, the brain overwrites the negative memory with a positive version, which will have a stronger presence.

The consequence of the recollection being rewritten time and time again, is that our heads are full of false memories of experiences that we imagine or hear about from others.

Alexandra Bright-Paul from the University of Bristol is one of many scientists to show that what you remember from a film is highly dependent on what other people say about the film.

In 2012, Bright-Paul made two groups of

kids watch different versions of the same film. The kids thought they had seen the same film, and subsequently, each individual was to discuss the film with someone from the other group. The experiment showed that when one person talked about episodes and details that only he had seen, the other often turned them into false memories, and the test subjects could not differ between what they watched and were told.

Similarly, your holiday memories may be false. The rubber dinghy in Portugal was not as far away as you thought, and you father did not swim very fast. But that was what he told you, and so, the brain automatically links the memory with the existing Estoril network.

SCIENTISTS PLANTED ANXIETY IN MICE

In an experiment, MIT scientists in 2014 investigated how the network of a recollection constantly changes.

Brain researcher Susumu Tonegawa and colleagues taught male mice that they would get electric shocks in one particular cage. By means of genetically modified neurons, the scientists made the recollection light-sensitive, so it could be

IN THE FUTURE:

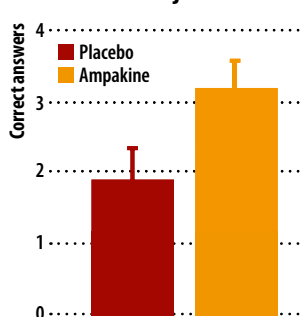
Forgetful? Take a memory pill!

Chemicals can improve your memory. That is the conclusion of an experiment, in which Dutch scientists gave a chemical, ampakine, to a group of healthy, elderly people and subsequently asked them to solve a number of minor problems.

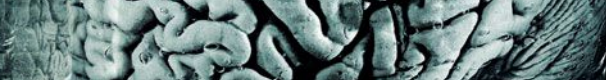
In one of the tests, the subjects were allowed to study a list, in which the numbers 1-9 had been paired with symbols. Subsequently, they were given a long list of haphazard numbers, which they were to pair with the correct symbols as fast as

possible. The results showed that ampakine caused a marked improvement of short-term memory, as the test subjects who were given the chemical scored 68 % better when they took the test right after seeing the answers.

Ability to remember paired numbers and symbols



Test subjects who were given ampakine got more answers right.



recalled by a ray of light. The electric shock was stored in the memory, so the mice subsequently flinched in fear, when they were placed in the cage – also when they did not get any shocks. The same reaction could be triggered by turning on the light in the mice's brains.

Subsequently, the scientists once again manipulated the mice's memory, so the negative recollection about the cage was once again linked with a pleasant experience. The male mice were joined by females, as the scientists regularly turned on the light to activate the old recollection about the cage. But now, the mice were having a good time, and so, the old, unpleasant recollection was overwritten. The light made the mice sexually aroused instead of afraid.

FALSE MEMORIES TO ERASE TRAUMA

Brain researcher Elizabeth Phelps has worked with post-traumatic stress disorder (PTSD) for years, believing that patients can be cured if their traumatic experiences are overwritten by false memories.

In patients with PTSD, the recollection of the trauma and the experience is stored in two different places in long-term memory, but they are so closely linked that the patient cannot think about the event without fear. In 2014, Phelps showed that the two recollections can be separated, if the doctor activates the bad experience and subsequently uses therapy to create a sensation of safety. When the recollection is retrieved, it is briefly unstable and sensitive to change. So, the anxiety can be overwritten.

The drug propranolol, which is used to treat high blood pressure, has proved to make the memory even more unstable; a fact used by scientist Alain Brunet.

In 2014, Brunet made patients with PTSD recall their traumatic experiences, causing sweaty hands and rapid heartbeat.

Half of the patients were given propranolol shortly before, the other half was given placebo. The therapy was repeated six times at one week intervals.

Subsequently, the scientists tested the heartbeat and sweat production, as the patients recalled their traumatic experiences. The results were striking. In the propranolol group, the therapy erased almost all anxiety, as the memory had been overwritten by a less scary one. **sci**

Improve your memory

If you need to remember something specific, you can use a number of simple tricks which all involve the memory's desire for images and for understanding what must be remembered.

JES LARSEN & SHUTTERSTOCK

USE YOUR GREY MATTER!



Make up a story

Shopping lists and driving directions are difficult to remember, because the individual parts do not make up a whole, increasing the risk that individual elements are stored separately in the memory and cannot be retrieved as a whole, such as when you are in the supermarket. You can help your memory by converting the list into a meaningful, coherent story.

EXERCISE: Write a shopping list and make up a trick to help you remember. You may imagine a dish, which includes all the ingredients (milk, rye bread, apples, cheese, lamb chops, etc.).

EXAMPLE:

The order of the planets:

Mabel – Mercury
volunteers to – Venus
eat – Earth
marshmallows with – Mars
Judith's – Jupiter
son and – Saturn
uncle – Uranus
Neil – Neptune



OTHER WAYS ...

Find the logic

Short-term memory remembers numbers and words by repeating them over and over again. If the numbers do not make sense, they must be repeated digit by digit, making them more difficult to remember. Help your brain by finding your own logic in the numbers and letters.

EXAMPLE:

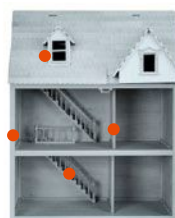
96SL11: The year my youngest was born, **96**, her two best friends, **Sandra** and **Leah**, my house number, **11**.

EXERCISE:

167123: Try it out yourself
KG06T25L: Try it out yourself
270TH8G: Try it out yourself

Make up images

Many people remember images better than words. Some things can be hard to relate to an image, but then you can make associations such as Vladimir Putin representing Russia. Similarly, you can remember a sequence by placing the individual elements along a route.



EXAMPLE:

The 5 biggest countries in the world
Vladimir Putin (Russia) is outside the house. In the hall, there is an ice hockey player (Canada). In the bathroom, there is a cowboy (US), in the kitchen, Mao Zedong (China) is doing the dishes, and a samba dancer (Brazil) is in the sofa.

EXERCISE: Continue with the next 5 countries: Australia, India, Argentina, Kazakhstan, and Algeria. Spend time practicing the route, as you can use it over and over again.

SPECIAL

Could sleep be the most important part of your day?

- 1: Consciousness
- 2: Intelligence
- 3: Memory
- 4: Sleep



Get a Little Shut Eye

By Gorm Palmgren

A never ending war rages in your brain between molecules that want to keep you awake and molecules that wish to lull you to sleep. The outcome of the war not only affects your sleep, it also influences your memory and the size of your brain.

JES LARSEN

BREAKTHROUGH:

Brain tissue needs a good night's sleep

Brain researcher Claire Sexton from the University of Oxford, England, scanned the brains of 147 test subjects at 3.5 year intervals, measuring their sleep quality. The study demonstrated that poor sleep has a fatal effect on brain tissue.

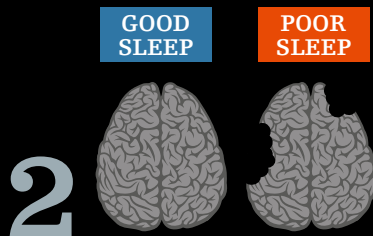
1. THE BRAIN IS SCANNED TWICE

At 3.5 year intervals, scientists scan the brains of 147 test subjects aged 20-84. In the period between the two scans, the participants' sleep quality is analysed several times.



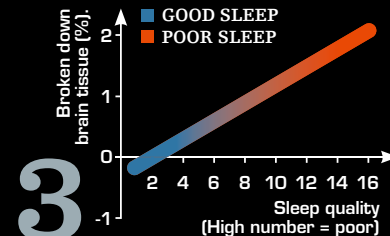
2. POOR SLEEP LEAVES ITS MARK

The two scans are compared. In several test subjects, the brain tissue in some parts of the brain has been broken down. The study reveals a direct connection between the breakdown and poor sleep quality.



3. ELDERLY PEOPLE MORE VULNERABLE

In the participants with the best sleep quality, the brain tissue has not been broken down at all, whereas 2 % of the brain tissue has disappeared in those with the poorest sleep quality. The greatest effect is observed in test subjects aged 60+.



When your eyelids become heavy at night, you feel the after-effects of a war that is fought every day inside your brain. The armies constantly fight for power of the brain. One wants to keep you awake, whereas the other tries to lull you to sleep. The two armies are controlled by two molecules: the orexin arousal molecule and the adenosine sleep molecule.

The outcome of the war is important, as it determines your sleep, and poor sleep could make the brain shrink.

Using sophisticated brain scanners, scientists have not only mapped out how sleep repairs and maintains our brains, they have also shown the potentially fatal consequences of lack of sleep.

TWO MOLECULES FIGHT FOR CONTROL

The never ending war in your brain begins and stops in the exact same way every single day.

During the night, the brain produces the orexin arousal molecule, which spreads across the brain from the hypothalamus region in the early morning. The molecule activates special neurons that wake up the brain and keep it awake during the day. And as the arousal molecule conquers the brain, the adenosine sleep molecule secretly rearms.

Adenosine reduces the brain's ability to send nerve signals and is a by-product emerging when the brain's neurons are energized by so-called ATP.

The adenosine concentration increases with the brain activity during the day. At night, the concentration becomes so intense that the brain gradually slows down, until we finally fall asleep.

66

When Deadwyler gave the monkeys orexin nasal spray, they were suddenly not tired any more

As we sleep, the sleep molecule is converted into the ATP energiser, whereas the production of the arousal molecule increases in the early morning. In the morning, the arousal molecule is once again in control, and we wake up fully rested.

The amazing powers of the tiny molecule has previously been demonstrated by brain researcher Sam Deadwyler of the US Wake Forest University.

In an experiment, he kept a group of monkeys awake for 36 hours. The lack of sleep made them so tired that they had a hard time completing a number of tasks, which they were otherwise good at. But when Deadwyler gave the tired monkeys orexin nasal spray, they were suddenly not tired any more and failed 15% less when completing the tasks.

In 2014, Chinese scientist Jianxia Xia demonstrated the influence of the two small molecules on your sleep. In an experiment, he injected the adenosine sleep molecule directly into the brains of mice. This made the animals so tired that they fell asleep after only 60 % of a normal day. On the other hand, an injection of the orexin arousal molecule extended the animals' day by 32%.

LIGHT SLEEP IN THE EARLY HOURS

When the sleep molecule has won the battle of the day, and you fall asleep, the brain carries out a lot of functions. While you are sleeping, the brain is able to maintain itself and repair minor damage that occurred during the day.

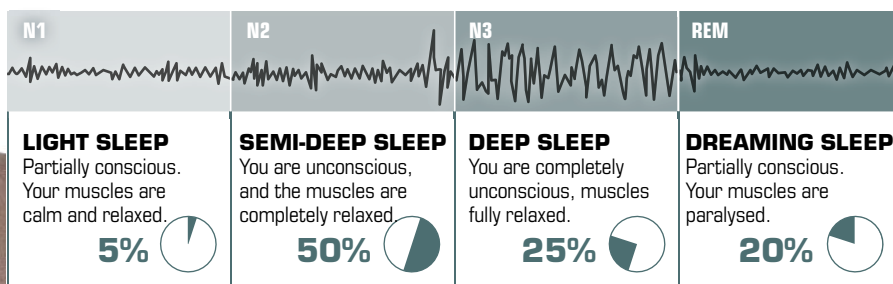
Scientists divide sleep into four stages: N1, N2, N3, and REM. Together with N1, the REM stage makes up light sleep, during which your brain activity is almost like when you are awake. N2 and N3 make up deep sleep, in which you are less conscious.

When the orexin arousal molecule can no longer defeat the adenosine sleep molecule, you will slowly fall asleep via N1. People often feel that they are almost awake during the light sleep of the N1 stage, but it only makes up 5 % of the sleep, and after only ►

Sleep paralyses the body

During the night, you pass in and out of four types of sleep. In total, they make up a cycle that is repeated several times during your sleep.

90 minute sleep cycle



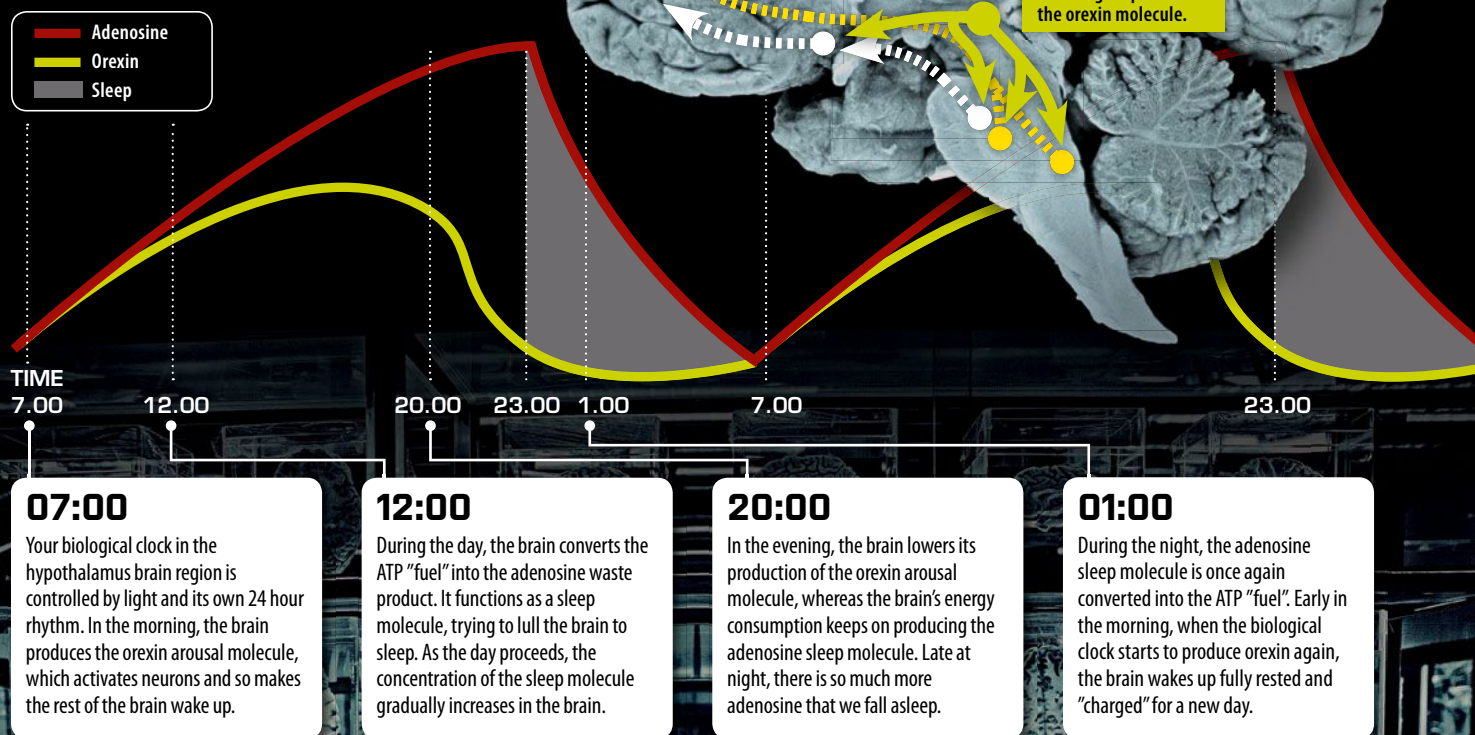
SHUTTERSTOCK

SLEEP

At night, when you are asleep, your brain is allowed to maintain itself, repairing minor damage that occurs during the day.

Waste products lull us to sleep

The rhythm of sleep and wakefulness is a constant battle in the brain between the orexin arousal molecule and the adenosine sleep molecule. Every morning, orexin wins, making us wake up, whereas adenosine wins late at night, so we go back to sleep.



The need for sleep decreases with age

Adults need less sleep than children, and during life, our need for sleep is more than halved.



FAST FACTS

264 hours and 24 minutes

is the scientifically documented record of remaining awake without any type of stimulant. The record was set in 1964 by a 17-year-old high school student from California. Afterwards, he slept for approximately 15 hours, and the next night approximately 10 hours, after which his sleep rhythm was back to normal.

YOUR BIOLOGICAL DAY IS 25 HOURS

The natural circadian rhythm of your biological clock is slightly longer than 24 hours, so if the brain is unable to sync according to natural daylight or other environmental factors, you will always want to go to sleep one hour later than the previous day.

► 10 minutes, you continue into N2, which makes up some 50 % of your sleep. There, you lose consciousness, and your muscles relax.

From the semi-deep N2 sleep, you move into the deep N3 sleep, in which you do not react to the surroundings. Your muscles are typically at rest, but this is also the stage in which people talk or walk in their sleep. You spend some 25 % of your sleep in N3 and from here, you pass directly or via the semi-deep N2 sleep into the REM dreaming sleep, which makes up some 20 % of your sleep.

The sleep stages occur in cycles, which each last some 90 minutes. From cycle to cycle, the sleep typically becomes lighter, so you will finally not reach the deep N3 sleep, but spend more time in N2 and the REM dreaming sleep.

SLEEP IMPROVES MEMORY

In an experiment, Tore Nielsen from the Canadian Université de Montreal showed how different sleep stages affect memory.

In the experiment, 22 test subjects played two different games, which require different things from our memory. In one, the Tower of Hanoi, discs must be moved back and forth between three stacks, until

they end up in a specific order. From earlier experiments, scientists know that the game requires a lot from the factual memory. In the second game, Corsi block-tapping, another person taps a number of blocks in random order, after which the test subject must repeat the order. This challenges the procedural memory. When



Brain scans have revealed that poor sleep breaks down brain tissue. Red and yellow indicate the most affected regions.

SHUTTERSTOCK & CLAUS LUNAU

the test subjects had become familiar with the games, they were allowed to have a good night's sleep, as the scientists analysed their sleeping stages.

The next day, the test subjects played both games again. Some had become better at the Tower of Hanoi, but not at

Corsi block-tapping. According to the sleep analyses, these participants had spent a relatively long time in the N2 stage, which had apparently improved their factual memory. Other test subjects had become better at Corsi block-tapping. This group had spent a relatively long time in the REM sleep stage, and that had apparently improved their procedural memory.

POOR SLEEP DAMAGES THE BRAIN

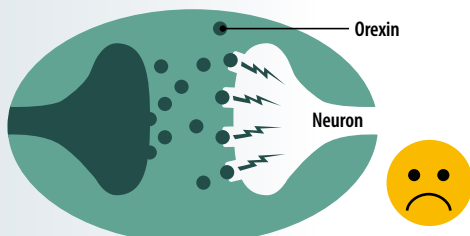
So, sleep affects the memory, and new studies demonstrate that poor sleep can be bad for the brain.

In an experiment, scientist Claire Sexton from the University of Oxford scanned the brains of 147 adults at 3.5 year intervals. The experiment showed that the better a person slept, the thicker the cerebral cortex of the frontal lobes, which is responsible for how we use knowledge. The scans also revealed that up to 2 % of the brain tissue was broken down in people with poor sleep quality. The older the person was, the more damage was caused by poor sleep.

Scientists do not know for sure, how lack of sleep can make the brain shrink. But as young children, whose brain size doubles

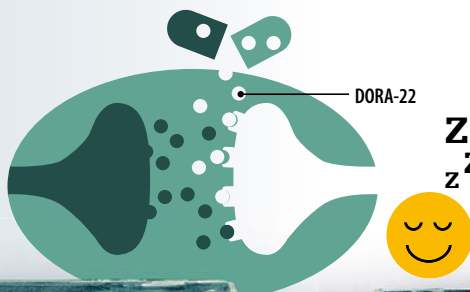
YOU ARE AWAKE

The natural orexin molecule binds to neurons, which are activated, keeping the brain awake.



YOU FALL ASLEEP

The DORA-22 of the sleeping pill binds to the neuron without activating it. Orexin cannot activate the neuron.



IN THE FUTURE:

Sleeping pills without side effects

American scientists are developing a new hypnotic agent based on the body's natural arousal molecule, also known as orexin.

Normally, orexin binds to some of the brain's neurons, activating them, so we wake up and remain awake during the day. The American scientists wish to make a synthetic version of orexin, DORA-22, which binds to the neurons without activating them. The synthetic orexin takes up the space on the neuron, leaving no room for the real orexin. So, the brain is not stimulated to remain awake, and sleep may gain the upper hand. In an experiment from 2013, the scientists showed that DORA-22 prolonged monkeys' sleep by up to 38 %. That is just as efficient as well-known hypnotic agents, but experiments have revealed that DORA-22 has fewer side-effects concerning the brain's response time and ability to solve specific problems.

JES LARSEN





Become wiser in your sleep

With a few simple tricks, you can practice piano playing and foreign languages, while you are fast asleep.

JES LARSEN & SHUTTERSTOCK

during their first two years, need a lot of sleep, they assume that the relatively low brain activity during sleep allows the brain to grow.

DEFECT REDUCES NEED FOR SLEEP

In spite of the beneficial effect of sleep, not all people need the same amount of rack-time. The different requirements have puzzled scientists for decades. Geneticist Renata Pellegrino studied the need for sleep in 200 people to find an answer.

The test subjects were only allowed four hours of sleep for five consecutive nights. When they were finally allowed to sleep on the sixth night, most slept for a very long time. But a small group did not need much extra sleep. Pellegrino studied all test subjects' genes and discovered that the DEC2 gene was responsible for the group's lacking need for sleep. The gene had mutated and no longer functioned correctly, so they needed one hour less sleep than the group that had the normal version of the gene.

In another study, the gene also proved responsible for an American woman having inherited her mother's slight need for sleep. In the study, the entire family's sleep was measured. The two women were fully rested after six hours and 25 minutes of sleep. The other family members averagely needed eight hours and six minutes. Scientist Ying-Hui Fu from the University of California in San Francisco identified the women's defective DEC2 gene and subsequently implanted the gene into mice, which slept 9 % less.

The DEC2 gene is not the only gene affecting sleep. In 2013, British scientist Michael Parsons discovered a gene that regulates both sleep quality and the ability to fall asleep. He found the gene by studying the sleep patterns of 1,000 test subjects. Three of them had a CACNA1C gene defect, which meant that they fell asleep twice as fast as the others. On the other hand, their sleep was poor.

Scientists are investigating how the CACNA1C and DEC2 genes affect our sleep. There are strong indications that they form part of the brain's biological clock as a type of "gear wheels", and if one mutates, the power balance between adenosine and orexin is disturbed, so we wake up/fall asleep at the wrong time. **sci**

Improve your piano playing... in your dreams

The brain remembers practiced motion such as playing the piano by means of procedural memory. In REM sleep, procedural memory is strengthened, so you become better at remembering practiced motion, learning it faster. The REM stage makes up a still greater percentage of your sleep the longer you sleep. So, you can improve your piano playing or other practiced motion by practicing before sleep.

EXERCISE: Practice your piano playing or overhead kick right before going to bed to have a good, long night's sleep.

OTHER WAYS ...

Improve foreign language as you sleep

The ability to remember specific knowledge such as words in foreign languages is known as the factual memory. This part of the memory is strengthened during the deepest sleep, which you mainly experience in cycles at the beginning of your sleep.

EXERCISE: Do your homework and then take a nap. Half of the time, you will be in deep sleep, in which knowledge is efficiently stored.



Smell your way to knowledge

If you subject your senses to a certain impression such as a scent as you try to learn something new, your brain will link the two. If the brain registers the scent as you are asleep, new knowledge will remain more easily.

EXERCISE: Place a vase of roses on the table and study a subject such as World War II. Move the vase to your bedside table, when you go to sleep. In the morning, you will remember your knowledge well.



RETHINKING PLANETARY THEORY

A BILLION IMPOSSIBLE WORLDS

Astronomers need to find new explanations of how worlds are born. Such is the conclusion after the discovery of 1,800 planets outside our Solar System. New observations reveal that several of those worlds should not be able to exist at all.

By Rolf Haugaard Nielsen

The world is not only stranger than we imagine. It is stranger than we can imagine." That is what famous biologist J.B.S. Haldane said about quantum mechanics, but the words might as well have been used about all the planets that exist outside our Solar System. So far, astronomers have discovered more than 1,800 planets, also known as exoplanets, some of which behave very strangely.

Some of the planets are too big, some have lopsided orbits, others are made of ice. But none of them should exist.

THEORY ONLY EXPLAINS OUR SOLAR SYSTEM

The behaviour of the exoplanets is

surprising, because for decades, astronomers were convinced that all star systems are born in the same way as our Solar System. According to classical planetary formation theory, the star systems should therefore be very similar to the Solar System.

The theory goes like this: a star and the planets are born in a flat disc of rotating dust and gas. The innermost planets such as Earth and Mars are small rocky planets, as the heat from the star was so intense at the time of formation that only substances with high melting points such as iron and rock could resist the heat. The massive lumps collided and grew into planets.

According to the theory, the amount of building materials in the innermost part of a star system is limited, and so, rocky

According to the classical theory, the planet HD 189733 b should not exist at all, because its orbit is too close to its star. MESA

WHAT IS AN EXOPLANET?

Location: Outside our Solar System

Size: It must have enough mass to be spherical.

Orbit: Exoplanets always orbit at least one star

► planets remain small, whereas gas planets further away, such as Jupiter and Saturn, get extremely big. Their cores contain ice and other substances with low melting points, which can only exist far away from the red-hot star. Gas planets grow even more, as their huge cores attract gas.

The theory was so simple that it had to be universal, as the same physical laws and principles apply throughout the universe. The distance to the star of the system determines planets' masses. But the discovery of 1,800 exoplanets shows that the old theory does not quite hold water.

PHYSICISTS WERE WRONG

When the first exoplanet was discovered in 1995, it attracted a lot of attention. The planet was a gas giant with a weight of 150 Earth masses – or almost half of Jupiter's mass. The world was orbiting its star, 51 Pegasi, fast at the modest distance of 7.5

million km. Translated into astronomical units (AU) – the distance between Earth and the Sun – that is just 0.05 AU. The orbital period (or year) of the planet is only four days. In comparison, the innermost planet of the Solar system, Mercury, orbits the Sun in 88 days. The gas giant's location surprised astronomers, as it could not possibly have formed in its present orbit. At the time of formation, the temperature would have been some 2,000 °C, and so water could not have frozen into ice in its core.

HUGE PLANETS HAVE LIMITED ORBITS

Astronomers nicknamed the planet a "Warm Jupiter", and they soon found more planets

100-600 million kg

That is how much mass the HD 189733 b planet sheds per second. It orbits so closely to its star that it is boiling away.

of the same type. Some 1 in 100 of the exoplanets so far discovered are Warm Jupiters with masses of one third to 10 times Jupiter's mass and often located 0.03-3 AU from their

stars, which is very close indeed. The classical theory turns out to be limited, and so, astronomers are trying to expand the model.

One possible explanation is that the gas giants moved towards the star after their formation. Scientists still think that the alien worlds were formed on the cold outskirts of the star system like Jupiter. But the gasses of the cloud posed enough resistance to slow down the gas planets.

The result was a spiral course towards the star, and the planet finally ended up in a much closer orbit. But life close to a star

THE CLASSICAL THEORY

BIG PLANETS FORM FURTHER OUT

According to classical planet formation theory, big gas planets with ice cores always form in the cold on the outskirts of a star system. Small rocky planets form close to the star like in our Solar System.

1 A cloud of gas contracts

All stars are born in a cloud of gas consisting of hydrogen, helium, and heavier elements. **The gas cloud grows, and gravity makes it contract.**

2 The star ignites at the centre of the cloud

The gas cloud rotates, and the gas accumulates into a flat disc with a dense core at the centre. There, the pressure and temperatures are so high that **hydrogen atoms fuse into helium**. The star begins to shine, as soon as the fusion power plant sets to work.

3 The temperature determines the location of the elements

Heavy elements collide and grow into lumps. **The heat in the innermost part of the system is so intense that the lumps are only formed by elements with high melting points such as iron and the minerals of rock.** Further away from the centre of the cloud, temperatures fall, and the lumps consist of rock and ice blocks made of water, methane, and ammonia.

may be very hazardous. Scientists have observed exoplanets being slowly consumed by their stars in several ways. The WASP-12 b gas giant's orbital period is around one day, and the close encounter means that the star distorts the exoplanet. Another gas planet, HD 189733 b, is also orbiting so close to its star that it is boiling away: Every second, the planet loses 100-600 million kg of mass in the form of water vapour and other gases.

LOPSIDED ORBITS ARE CONFUSING

The next surprise was the discovery of planets with lopsided or inclined orbits. According to the classical theory, any planet of any star system will be born in a disc of gas rotating around the newborn star in the same direction as the star itself. So, lopsided orbits are unimaginable, as all the planets of the Solar System orbit in the same ►

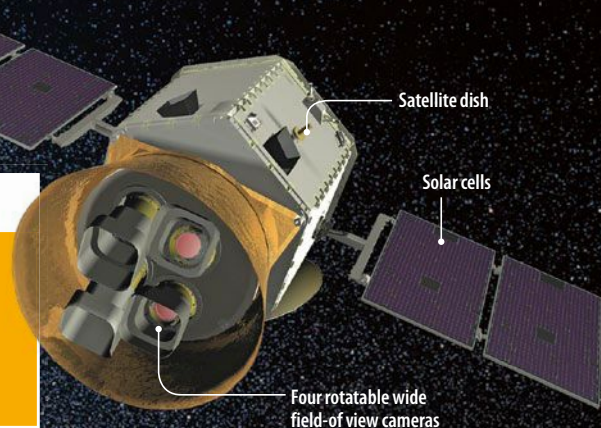
SPACE SATELLITE WITH SUPER VISION

Name: Transiting Exoplanet Survey Satellite (TESS)

Orbit: Will have an elliptical orbit 108,000-373,000 km above Earth

Planned launch: 2017

Mission duration: Two years



New satellite to find Earth-like planets

A new telescope is intended to find planets near 500,000 of the closest stars in the Milky Way. In 2017, NASA will launch the Transiting Exoplanet Survey Satellite (TESS), which will use its super vision to discover planets. TESS is to find the worlds in the same way as the successful Kepler space telescope – by

recording the shadows of the planets as they pass in front of their stars. Kepler does not cover all of space, but TESS will be able to scan it all using its rotatable cameras. TESS will spot planets of all sizes, from gas giants to small rocky planets, but it will primarily aim to find rocky planets like Earth.

4 The lumps grow into planets

The lumps of matter collide and grow bigger. **The small rocky planets form at the centre in the burning heat. On the other hand, the planets in the cold, external part of the star system grow into giants**, as the quantity of building blocks in the form of ice is greater. At some point, these planets become so heavy that they begin accumulating gas from their surroundings.

5 Stellar winds blow away the gas cloud

Winds of particles and radiation from the young star blow the remaining gasses out of the newly formed planetary system. In our Solar System, this resulted in four small rocky planets near the centre and four big gas planets further out. **All planets orbit the Sun's equator.**

THE THEORY FAILS HERE

BECAUSE

EXOPLANETS ARE WAY TOO BIG

Many gas giant exoplanets orbit close to their stars, but according to the old theory, the close contact should not occur, as gas planets form further out. The theory also cannot explain, why many rocky planets have become huge, as the mass is too limited for rocky planets to grow so big.

BECAUSE

INCLINED ORBITS ARE NOT POSSIBLE

So far, physicists used to believe that all planets orbit their stars in relatively flat orbits, but that is not always the case. Several exoplanets have inclined or even lopsided orbits at a different plane than the original disc. The theory cannot explain how the extraordinary orbits originate.

► direction and at more or less the same plane around the Sun's equator.

Once again, the theory fails when we observe exoplanets. WASP-7 b orbits its star's poles, whereas two planets of the Kepler-56 system speed around their star at an angle of 45 degrees as compared to the star's equator. HD 80606 b has a wildly elliptical orbit, in which it is only 0.03 AU from the star at one end. At the other extreme, the planet is 0.8 AU from the star. And HAT-P-7 b even orbits its star in the opposite direction to the star's rotation. Some 10 % of the known exoplanets have orbits that cannot be explained.

According to scientists, two planets can be knocked off course, when they get so close to each other that their mutual gravitational pulls hurl them in unexpected directions. The new orbits may cause havoc in the entire system, so more planets affect each other's orbits with their mutual

gravitational pulls. One last group of planets consists of rock like Earth does, and they have masses up to 10 times Earth's. So, they have been given the rather groovy name of "super-Earths".

SUPER-EARTHS APPEAR EVERYWHERE

The super-Earth designation is only based on the planet's mass. The group is often very interesting, as these worlds could support life. Our Solar System includes no super-Earths - Neptune comes closest with a mass of some 17 times Earth's. Super-Earths are quite common. They exist near 40 % of the closest Sun-like stars. Super-Earths with low density are small gas planets, whereas

2 hours and 10 minutes

**That is the length of a year
on the PSR 1719-14 b planet.
It orbits 1,000 times closer
to its star than Mercury
orbits the Sun.**

worlds with medium density are called waterworlds, as they primarily consist of ice. Super-Earths with high density are made of rock and iron like Earth. The

big rocky planets and the waterworlds are interesting, as life may thrive on them, if they are located at such a distance from the star that temperatures allow liquid water to exist on the surface.

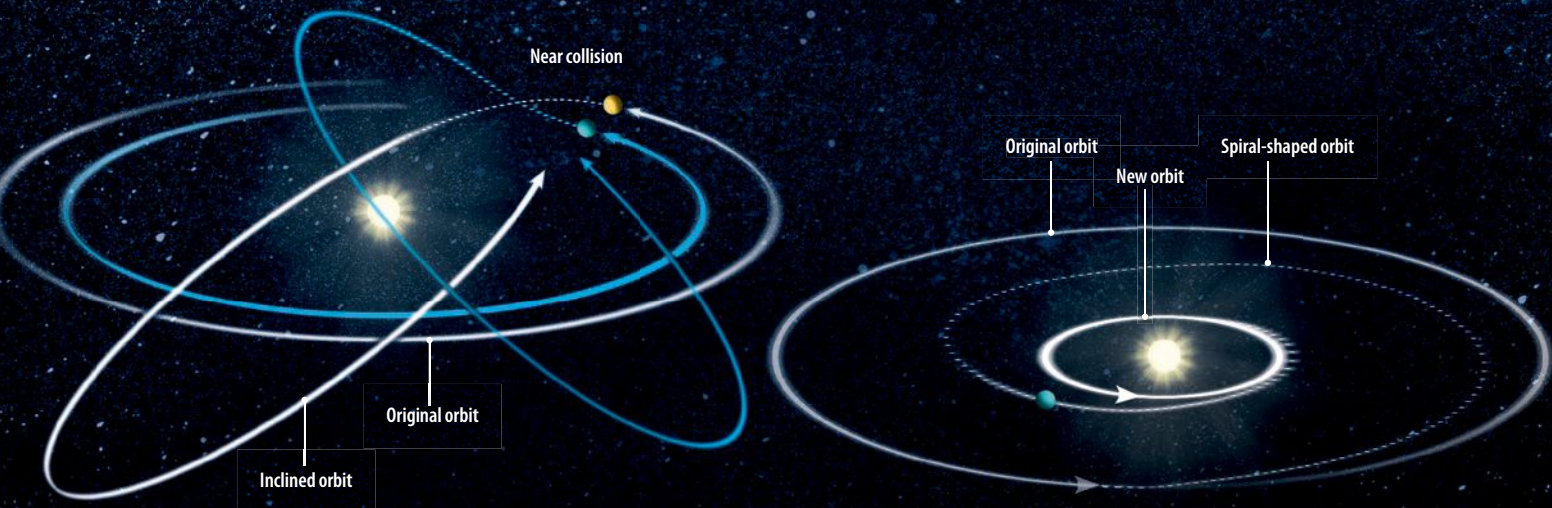
GAS CLOUDS MAKE TELESCOPES BLIND

Many big super-Earths orbit extremely close to their red-hot stars, and like the Warm Jupiters, they remain great mysteries, as once again, the classical theory does not support them. According to the theory, not

2 NEW THEORIES

HEAVENLY BODIES ON COLLISION COURSE

According to physicists, some of the newly discovered star systems formed in a more chaotic way than ours and hold much more mass. So they behave differently.



A Planets fling each other into lopsided orbits

Many exoplanets have elliptical orbits, probably due to near collisions in the early childhood of the system.

Two big planets could have come so close to each other in their original orbits that gravity flung them into unexpected directions, so they ended up in elliptical, lopsided orbits as compared to the plane of the gas disc.

B Big gas planets aim for the star

According to astrophysicists, gas giants on the outskirts of a star system could encounter so **much frictional resistance from gases in the cloud that the planets lose energy and start to fall inwards**. This mechanism could explain why big planets can exist close to their stars, though heat and lack of mass should prevent their formation there.

enough heavy elements existed close to the stars at the time of formation for super-Earths to be born. One possible explanation of the existence of super-Earths is that much bigger quantities of heavy elements exist in the innermost regions of some star systems than is the case in our Solar System. The super-Earths may also have been born further away and moved towards their sun. Some small super-Earths may even be former gas planets that lost speed, moved towards the star, and lost their atmospheres, so only the rocky core remains.

Both theories are hard to prove, as existing telescopes have trouble looking through the thick cloud of swirling dust and gasses in which the planets are born. But the ALMA telescope has taken razor-sharp pictures of a flat gas cloud around the young star HL Tauri (in the Taurus constellation), revealing rings of new, planet-like bodies under formation in the disc. **ESO**

Huge telescope to reveal water in habitable zones

From 2022, the world's biggest eye will peer into space and spot Earth-like planets near our closest stars. Known as the European Extremely Large Telescope, E-ELT, the telescope is built in the desert of Chile. It is going to take photos of planets and collect information about their surfaces and atmospheres. The most interesting heavenly bodies are Earth-like planets in the so-called habitable zone around a star, where liquid water can exist on the surface of the planet. All life forms need water, and so, astronomers follow the water, when looking for life in space. The E-ELT captures the light from the worlds, breaking down

filters. All gasses emit light of a specific wavelength, and so, the E-ELT will be able to measure the precise gas content of the planets' atmospheres.



In June 2014, the peak was blown off a mountain to make room for the E-ELT.

1. A 39.3 m mirror consisting of 984 hexagons captures huge quantities of light from the night sky. The light is reflected onto more mirrors with different functions.

2. The light from the main mirror is concentrated in a small mirror on top of the structure and shot back onto a third mirror moving with the large mirror. This improves the focus of the image.

3. The light is directed to a mirror, which changes shape 1,000 times per second. This removes atmospheric disruption from the image.

4. The final mirror stabilises the image and directs the light towards the camera and other measuring instruments.

THE E-ELT TO RECORD LIGHT FROM PLANETS

Name: European Extremely Large Telescope, E-ELT

Location: Mount Cerro Armazones in northern Chile

Expected weight: 2,800 t

Completed: 2022

Hunter-gatherers and peasants shared the land. The hunters caught wild animals in the forests, while the peasants cultivated the soil.

PER O. JØRGENSEN



WHEN TWO PEOPLES RULED EUROPE SAME PLANET: DIFFERENT WORLDS

For millennia, hunters ruled Europe, until they suddenly disappeared around 5000 BCE. Until recently, scientists thought they were massacred by immigrant farmers, but new finds reveal that the two Stone Age peoples didn't just live in Europe at the same time – they also lived together.

By Rasmus Kragh Jakobsen

They came suddenly, the strangers. From one day to the next, the forest was echoing with the sound of their axes cutting down old trees to get building material. Longhouses mushroomed in clusters, and hunting grounds were planted with barley and wheat.

Although the tribal warriors took up arms, they could not stop the newcomers, of whom more and more were arriving. Before long, the tribes had almost been wiped out, and the few who survived the massacre had been driven far to the north.

That is what scientists thought happened when the first peasants arrived in Europe, entering the hunters' territory. But new archaeological discoveries indicate that the encounter between the two cultures was not just a dramatic fight for land, life and death. It looks as if farmers and hunter-gatherers lived peacefully side by side in

Europe for thousands of years.

Archaeologists know that agriculture spread to Europe from the Anatolian Plateau in what is now Turkey. Scientists have been able to observe the culture's venture to the European continent from finds made in 7,000-year-old soil layers. Postholes from farmhouses and characteristic potsherds multiply after a certain point, and then, all

evidence of the nomadic hunter-gatherers, who had ruled Europe for 45,000 years, disappears. The abrupt shift between the two cultures

previously made archaeologists believe that the first peasants defeated the original population, quickly wiping it out and conquering its territory.

GENES DOCUMENT HISTORY

In recent years, archaeological artefacts have been supplemented with the new

scientific field of fossil genetics. Studies of genetic material from skeletons dating back several millennia have revealed crucial new evidence of what really happened, when the two lifestyles met. One of the most ►



JURAJ LIPKAC

DNA from 364 prehistoric humans demonstrates that hunters and peasants mixed, creating a brand new culture.

Agriculture led to cities and writing

Cities Farming makes people settle down in one place, such as a village of 100-500 inhabitants. The settlements later develop into real cities with official structures: temples, warehouses, palaces, and markets.



Civilisation Farming produces a considerable surplus of food, and some people need no longer provide for themselves. New economic "surplus classes" appear, and political and economic power is centralised and exercised by a controlling government.



Written language

The first written language emerges as a result of the need to keep count of people and stores using simple symbols, which later develop into more precise, written languages.



Science & technology

Technological sophistication gathers pace with agriculture, as new production technologies quickly develop. In addition, the surplus food allows some people to work with new crafts and trades, and written language provides the basis for ideas to be exchanged.



GETTY IMAGES/TEOMANCIMIT

66 **Farmers and hunter-gatherers do not only manage to live side by side – they also had children.**

► surprising results of the DNA studies were contributed by a group of scientists from Johannes Gutenberg University in Germany. The scientists studied DNA from skeletons in a cave by the name of Blätterhöhle in Hagen, Germany. For millennia, the cave functioned as a type of catacomb, in which people buried their dead. DNA from 25 skeletons demonstrates that the hunter-gatherers and farmers used the same cave as a burial site for no less than 2,000 years, living – and dying – side by side.

Analyses of the skeleton teeth show that the two cultures had very different eating habits. The hunters mainly ate fish, whereas the peasants lived on grain, indicating that they shared the land and the resources between them. The hunters fished in the rivers, whereas the peasants cultivated the fields.

Although scientists only have data from one place, they believe that this type of coexistence was probably prevalent everywhere in Europe, where farmers and hunter-gatherers met.

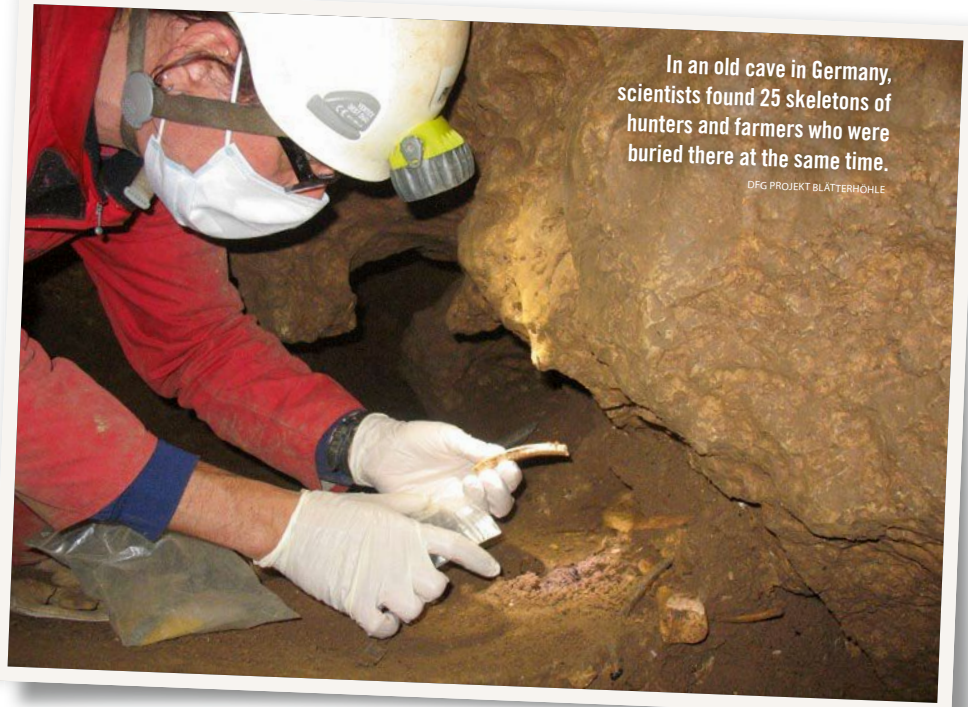
MIXED GENES

The coexistence theory is supported by the most extensive study of prehistoric peoples'

genetics so far. Another group of scientists from the Johannes Gutenberg University has sequenced the genes of 364 skeletons found in 25 places in the Mittelbe-Saale region of Germany – a part of Europe which many different cultures passed through.

The scientists can see that although the hunter-gatherer genes almost completely disappeared from Central and Southern Europe in the first place due to the large group of newcomers, the culture did not go extinct. Farming spread further north, and the peasants once again encounter the

hunters. When they meet, they not only manage to live side by side – they also team up into a whole new culture known as the Funnelbeaker culture. The new culture is characterised by a mixture of the lifestyles of hunter-gatherers and farmers. The new culture are a pastoral people, who keep livestock just like farmers and make the same funnel-shaped pottery that inspired the name of the culture. But the new people also go fishing and hunt wild animals just like the original hunters did. After 1,000 years, the new culture moves south in Europe,



In an old cave in Germany, scientists found 25 skeletons of hunters and farmers who were buried there at the same time.

DFG PROJEKT BLÄTTERHÖHLE

Hunters were nomadic. Peasants built cities

Farmers and hunter-gatherers lived very different lives. The peasants' settled lives as compared to the hunters' nomadic culture meant that the peasants were better at surviving.

HUNTER-GATHERER

Work: Less than 4 hours/day.

Difference between the sexes:

Huge differences. Women gather supplies and look after children. Men hunt.

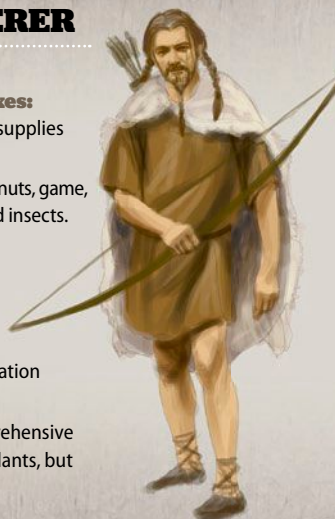
Diet: Varied, including fruit, roots, nuts, game, lots of fish, leaves, seeds, eggs, and insects.

Dwelling: Nomadic life style, depending on where the food is.

Birth rate: Women have a child every four years.

Social structure: Flat organisation without class differences.

Balance with nature: Comprehensive knowledge about local animals/plants, but varying availability.



FARMER

Work: Often more than 8 hours/day.

Difference between the sexes:

None really. It is necessary that men, women, and children work in the fields.

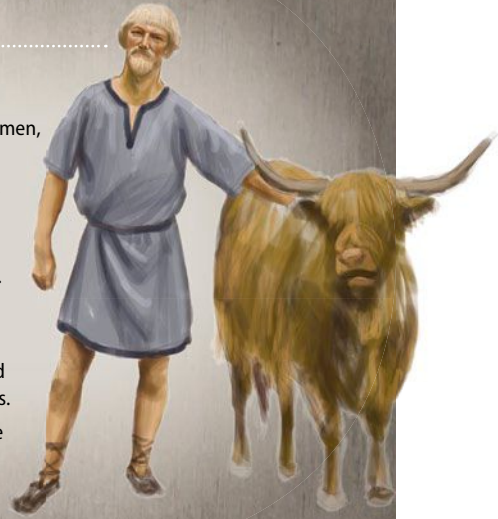
Diet: Uniform and dominated by grain, meat, eggs, and dairy products.

Dwelling: Settled life style, as food production only requires a few hectares.

Birth rate: Women, on average, have a child every two years.

Social structure: People are divided into a rich upper class and poor peasants.

Balance with nature: Considerable food safety, but also problems with pollution, diseases, and exhausted soil.



PIRO JORGENSEN

mixing with the farmers and once again spreading the hunter-gatherer genes.

A Swedish group of scientists from Uppsala University has also found genetic remains of the North European mixed culture of hunters and peasants. In their studies of eleven 5,000-7,000-year-old Swedish skeletons, they can see how the characteristic genes of the peasant culture were mixed with genes from the hunters. The discovery demonstrates that the farmers did not suppress the original people, rather they were in close contact with each other, exchanging knowledge and even mating and having children.

PEASANTS ULTIMATELY OUT-COMPETE HUNTERS

Although the peasant culture did not all at once eradicate the hunter-gatherers, the ancient culture was out-competed in the end by a new, smarter way of life.

The farming lifestyle involved inherent advantages as compared to the hunters', such as being able to build permanent settlements. This meant that it was easy for them to have many children, and their numbers grew quickly. In addition, farming and livestock-keeping meant much less food scarcity – and if the winter turned out particularly cold and long, or if the crops failed, the peasants could subsist on the surplus from previous harvests.

The number of farmers grew, but the hunters declined and became more scattered. They could never be sure to find food, and due to their nomadic culture, they could not have as many children – too few to maintain the population. Meanwhile, the expanding fields and settlements of the farmers meant that hunter-gatherers had to leave their hunting grounds. So, the hunter-gatherers were not quickly and brutally wiped out by the newcomers: they were quietly submerged in a sea of peasants.

Agriculture and livestock-keeping produced a surplus of food, so some people did not need to provide themselves with food. The Europeans could spare time to develop new crafts and technologies. The surplus food was also traded, and in order to be able to keep tabs on the amounts of grain in stock, written language develops. Consequently, the new peasant lifestyle paved the way for economics, cities, and written language: all the characteristics of modern civilisation. **BCI**

ALLAN HOJEN

Peasants conquer Europe several times

Europe's ancient hunters were out competed by the first European farmers – but the peasants were also beaten by a new culture, which conquered the continent at a later point.



DNA analyses have revealed that several different cultures swept across Europe at different times.

THOMAS HARTMANN

Hunters driven north



5500-4775 BCE

After being a hunter-gatherer domain for some 40,000 years, Europe is "invaded" by a new ethnic group from what is now Turkey – the first farmers. They live in large longhouses in small settlements and make pottery with lines, hence the name: the Linear Pottery culture. The new people drive the hunter-gatherers north.

New peasant-hunter culture



4100-3100 BCE

Central European farmers migrate to Scandinavia, where they mix with hunter-gatherers. A new, so-called Funnelbeaker culture develops, which makes funnel-shaped pottery and sharp-edged stone axes and bury their dead in dolmens. Some 1,000 years later, the descendants of the new culture migrate south, once again spreading the hunter-gatherer genes.

High-tech culture conquers Europe



2800-2200 BCE

Immigrants known as the Corded Ware culture arrive from the east, bringing pottery with new characteristic shapes and patterns. At the same time, the Bell-Beaker culture arrives from the Iberian Peninsula. Commanding the most recent technology and metal blades, they drive out a major part of the existing population. Peasants have their own farms, land, and animals.

An unknown bear species may exist high up in the mountains of Nepal, India, and Tibet.

GETTY IMAGES/SHUTTERSTOCK



DNA ANALYSES:
COULD
THE YETI BE AN
UNKNOWN
BEAR?

Scientists have found evidence that the Abominable Snowman may exist – and that the animal is related to a 40,000-year-old, extinct polar bear. So, a big, unknown mammal could still roam the Himalayas...



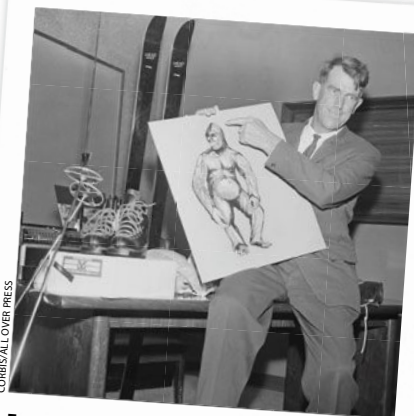
By Rasmus Kragh Jakobsen

The inaccessible regions of Earth's highest mountain range may keep a big, hairy secret: an unknown bear species, which is roaming the 2,400-km-long Himalayas, where the animal has managed to avoid contact with the few locals for millennia.

The hypothesis arose in connection with a new DNA study, which revives the old myth about the Yeti – a big, strong, hairy monkey or bear-like creature, which is believed to live in the mountains of Nepal, Tibet, and India. Scientists have analysed the DNA from two hair samples found in India and Bhutan, which are supposedly from the legendary Abominable Snowman. According to the study, the genetic material of the sample is the same as what scientists recently found in a jawbone from a 40,000-year-old, extinct polar bear species in Svalbard, Norway.

YETI REMAINS FOUND IN VILLAGE

One of the two mysterious DNA samples was found by mountain climber Christophe Hagenmuller 10 years ago in the mountainous Indian Ladakh region near the Tibetan border. There, he met a man, who had been injured falling off his horse.



Even prominent Western mountain climbers such as Sir Edmund Hillary claim to have seen the Yeti in the Himalayas.



Several photos of mythical animals have been published over the years, but like this Bigfoot, all proved to be hoaxes.

Christophe Hagenmuller helped the man back to his village, and as a reward, the villagers showed him something very unusual: a mummified animal, which did not look like anything Hagenmuller had ever seen before. The animal resembled a hybrid of a bear and a wolf, it was the size of a human, and had golden brown fur and a large mouth full of very sharp teeth.

The villagers claimed the animal was shot by a bear hunter 40 years previously, and back then, the experienced hunter said that the animal was not a bear – it had acted in a

markedly different manner and was so aggressive that he shot it, fearing for his life. According to the villagers, the animal was really a Tengmo, the local word for the Yeti or the Abominable Snowman.

Until that day, nobody outside the village had seen the remains of the animal, and the villagers made sure to keep both their unusual Tengmo and the location of the village a secret. Nevertheless, Hagenmuller was allowed to take a small sample of the animal's fur as a souvenir from his visit to the village in the Himalayas. ▶

Large animals 'hide' from science

If an unknown bear species exists in the Himalayas, it is not the first time that a large mammal has managed to remain unseen. Even today, scientists discover new species.



PANDA

Scientists search for bear for 60 years

1869: The panda is officially discovered by the West in 1869, when a dead bear is found. But another 60 years pass, in which scientists search the Himalayas in vain to find more specimens of the iconic, black and white bears, until they manage to shoot one.



SAOLA

Ox hides deep inside the forest

1992: In remote villages, scientists spot trophy skulls from an animal they do not recognise. They turn out to be from a new ox species, the so-called saola. The animal is familiar to the locals of Vietnam and Laos, but is one of the world's rarest wild creatures.



TAPIR (TAPIRUS KABOMANI)

Discovery of new species is a zoological sensation

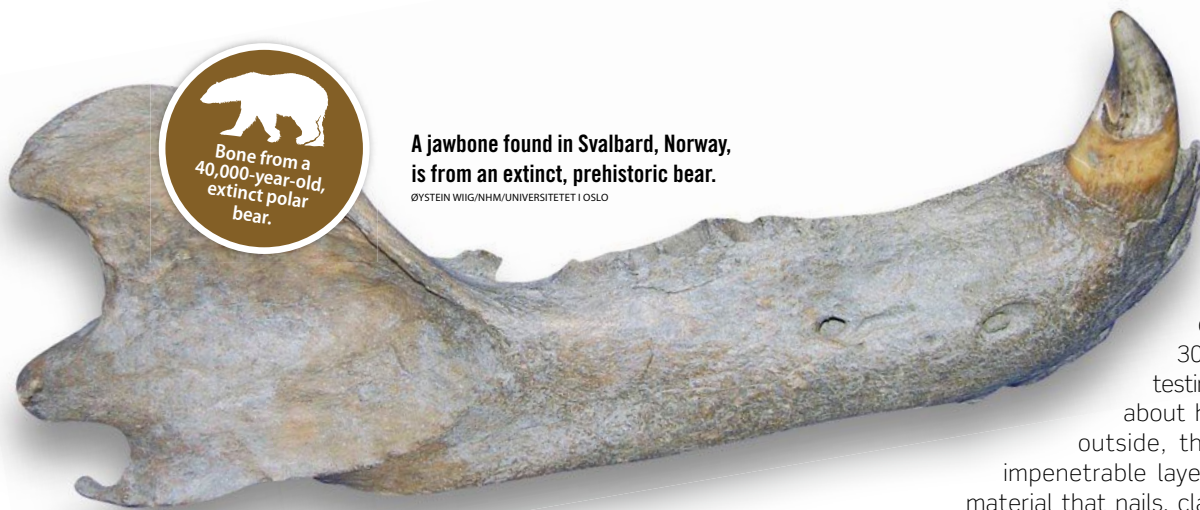
2013: In the Amazon region of Brazil, scientists make an unusual discovery: a new tapir species. It is described as the most sensational discovery of a terrestrial mammal made this century – though the locals have known it for a long time.



OKAPI

Europeans laughed at the description

1901: For many years, the Europeans ridiculed the myth of an animal which is apparently a hybrid of a giraffe and a zebra. But when a British explorer sends back skins and skulls of the animal, the Europeans realise the okapi really exists.



A jawbone found in Svalbard, Norway, is from an extinct, prehistoric bear.

ØYSTEIN WIIG/NHM/UNIVERSITETET I OSLO

plausible background stories, from Asia, Russia, and the US. They managed to extract DNA from 30 of the samples for testing. The special thing about hair is that on the outside, there is an almost impenetrable layer of keratin - the material that nails, claws, horn, etc. are made of. So, the scientists can use harsh chemicals to cleanse the samples of all foreign DNA on the outside without harming the original DNA inside the hair.

Subsequently, the scientists sequence a small part of the genetic material that all organisms from yeast to humans have in common, but which varies slightly in the genetic code, making it possible to spot the difference between species.

When the analyses had been completed, it was soon clear that in most cases, the samples came from ordinary, well-known animals that live in the regions in which they were collected: cows, horses, sheep, hedgehogs, and even a human. The sample

► DNA TO REVEAL FABLED BEAST

Seven years later, Hagenmuller becomes aware of a rather unusual inquiry. An established geneticist, Professor Bryan Sykes from the University of Oxford, England, is looking for remains of various different types of mythical creatures.

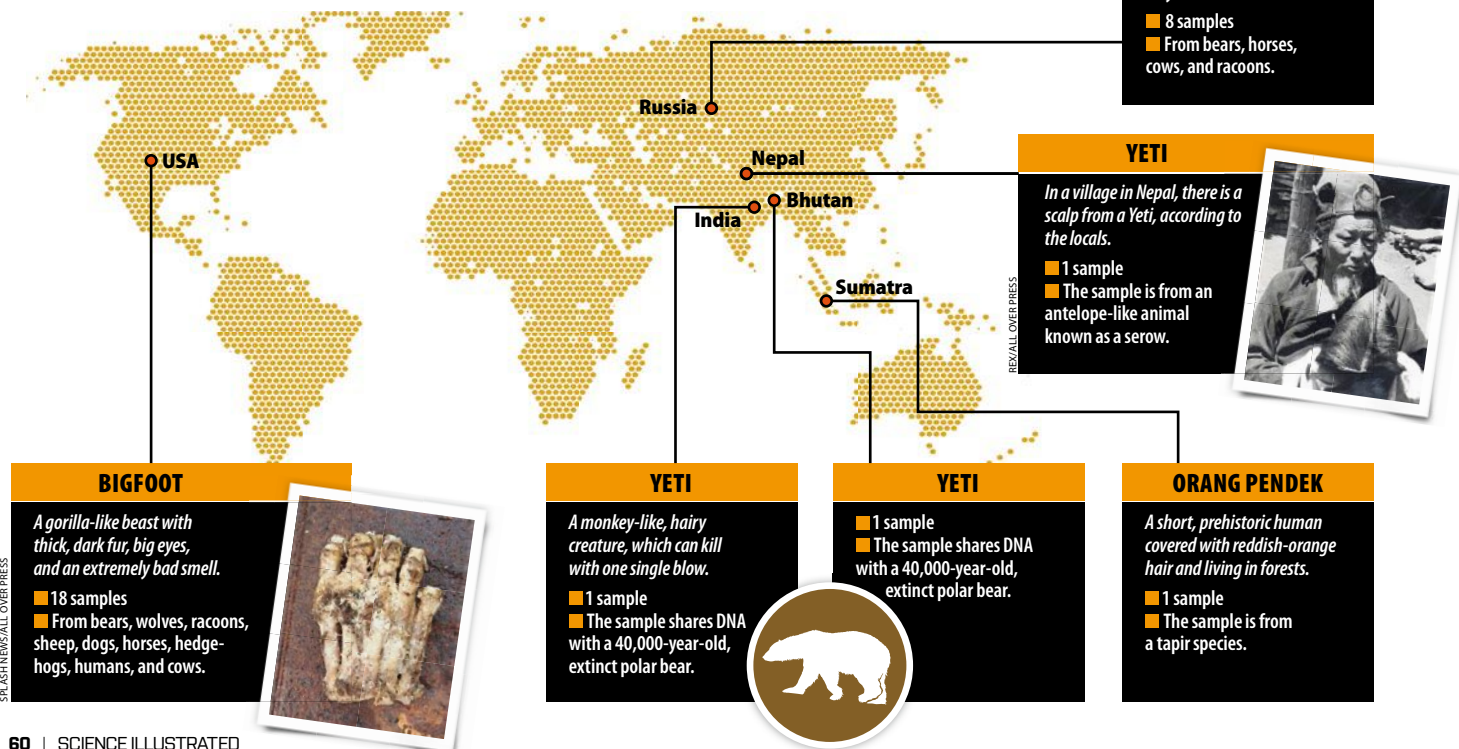
Almost any part of the world has its own myth of an obscure or mysterious creature that roams deserted regions. In the US and Canada, stories are told about the ape-like Bigfoot or Sasquatch. Indonesia has its short people, known as Orang Pendek, who live in the woods, and in Russia, legend has it that

the Almasty caveman still survives out in the wilderness. Like many others, who are interested in cryptozoology - the study of legendary animals - Bryan Sykes hopes to find evidence that all the myths and legends about Abominable Snowmen and human-like creatures are true. In cooperation with the head of the Lausanne Museum of Zoology in Switzerland, Michel Sartori, he decided to use the most recent genetic technologies to extract DNA from the samples and find out from which creatures they stem.

Many people from all over the world approached them, and very quickly, the two scientists collected 37 hair samples with

So many samples, so many lies

30 hair samples believed to be from different variants of the Yeti have undergone DNA testing. Most of them are from ordinary animals, but two stand out.



66

Today, the entire Earth has been mapped out, and scientists very rarely discover new, big mammals. However, there are still small, unexplored spots...

from India and one other sample found in Bhutan hold a big surprise: The sequenced genetic material is 100 % the same as the DNA from a polar bear jaw excavated thousands of kilometres away in Svalbard, Norway. The bear is an extinct species that last lived 40,000-150,000 years ago.

HYBRID ROAMS THE MOUNTAINS

The result indicates that the mysterious hair samples are from a so far unknown bear species that lives in the region around India and Bhutan and is related to polar bears. According to a different theory, the samples are from a hybrid between the brown bear

and the polar bear. The hybrid may have originated a long time ago, when the two bears split into two different genetic lineages. If so, the unknown bear in the Himalayas would be the modern descendant of the hybrid. That could explain why the bear includes polar bear DNA.

According to sceptics, Yetis and short, unknown woodmen are pure myths. Today, the entire Earth has been mapped out, and scientists very rarely discover new, big mammals. Consequently, it is highly unlikely that the fabled animals exist. However, there are still small, unexplored spots on Earth, which sometimes manage to surprise scientists. For instance, a new ox species by the name of saola was discovered by accident in 1992, and a new, unknown tapir emerged in the Amazon region of Brazil in 2013.

With their DNA study, the scientists have definitely eliminated a number of the most promising Abominable Snowman candidates in the US and Russia plus the short Orang Pendek woodmen. But they cannot rule out that the Abominable Snowman may exist - not an ape-man, but an ancient, unknown bear species that might just live high up in the Himalayas. **SCI**

DNA could kill mythical beasts

Scientist Bryan Sykes' study of hair samples, which are reportedly from the Abominable Snowman, is the first of its kind in the world. Using DNA analysis as a new tool in cryptozoology – the study of legendary animals – many myths can be tested. All you need is physical samples from animals, from which genetic material can be extracted. And there are plenty of myths to choose from. Apart from legends about different variants of the Abominable Snowman, myths are told about monkey-like creatures such as the Indian Mande Barung, the Brazilian Mapinguari, the Yowli from Australia, and the Indonesian Orang Pendek 'short people'. Other mysterious creatures such as the Loch Ness monster, which is only known from grainy pictures and reports, cannot be tested, as no hair or tissue samples from the lake monster exist.

Bryan Sykes' DNA analysis is the first cryptozoological study which has been published in a reputable journal.

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MA/SCI35

10 YEARS AGO: THE FIRST PROBE LANDS ON TITAN

Launch: 1997

2005

2015

2005: Landing on Saturn's biggest moon

10 years ago, the Huygens space probe was the first ever to land on Saturn's moon Titan. Before the landing, the Titan was a mystery to astronomers.

2015: The mission is still solving Titan's mysteries

Huygens was carried to Titan on the back of a bigger space probe, Cassini, currently orbiting Saturn. Although Huygens sent its last message back to Earth right after landing on Titan, astronomers still learn new things about the moon, each time Cassini flies by Titan.

-180°C

The temperature on Titan is 100 degrees lower than the most extreme winter temperatures in Antarctica.

A TINY FROZEN WORLD

Wind, lakes, and an atmosphere including the building blocks of life: Titan resembles an early version of Earth – only locked in a deep freezer. So, Saturn's moon may help us solve the mystery of the origin of life on Earth.

By Julie Hjerl Hansen & Lone Djernis Olsen

SHUTTERSTOCK/THINKSTOCK

Titan's surface is covered with hundreds of lakes. So, astronomers consider the moon one of the most Earth-like worlds in the Solar System.

On 14 January 2005, the 317 kg Huygens space probe starts its descent through the atmosphere of Titan, largest of Saturn's 53 named moons. On the way, sensors register the pressure and chemical make-up of the atmosphere. A parachute unfolds, and Huygens lands softly on Titan's frigid surface. Before the landing, Titan is a mystery to astronomers.

They know that the moon is the only other known body to have a dense, nitrogen-containing atmosphere. But it comes as a surprise that the mist is hiding a world reminiscent of the young Earth. Titan proves to be the only other place with stable, liquid lakes on the surface. But the moon only receives 1 % of the sunlight that Earth does, and so, the average surface temperature is a cryogenic minus 180 °C. The extremely low temperatures mean that all water on Titan exists in the form

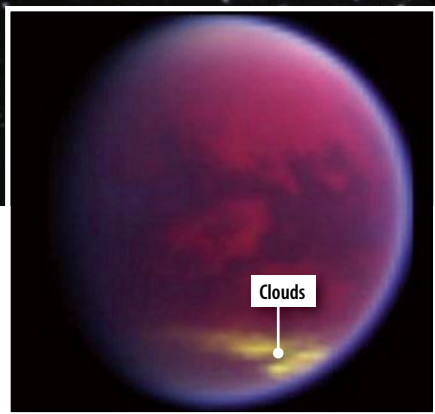
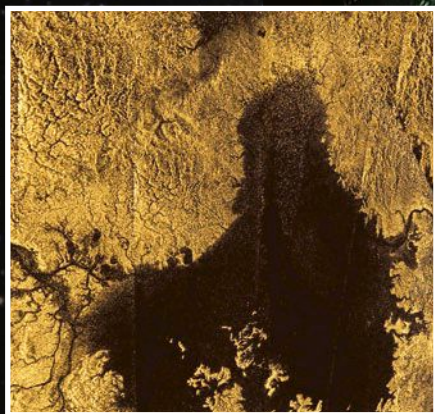
of ice as hard as rock. The lakes are not full of water like on Earth. On Titan, methane rains from the sky, producing canals and lakes. During its descent, Huygens measures the atmosphere to consist of methane and nitrogen, including slight amounts of ammonia. Since then, measurements have demonstrated that the mist surrounding Titan probably contains nucleotides. These are the building blocks of DNA – the genetic material in most life on Earth. Consequently, scientists hope that Titan can help solve the mystery of how the first life originated on Earth.

CHANGING SEASONS

Only three minutes after landing, the Huygens probe sends its last message back to astronomers on Earth. But the message is not the last that scientists hear of Saturn's moon. Huygens travelled to Titan on the side of a ►

TITAN

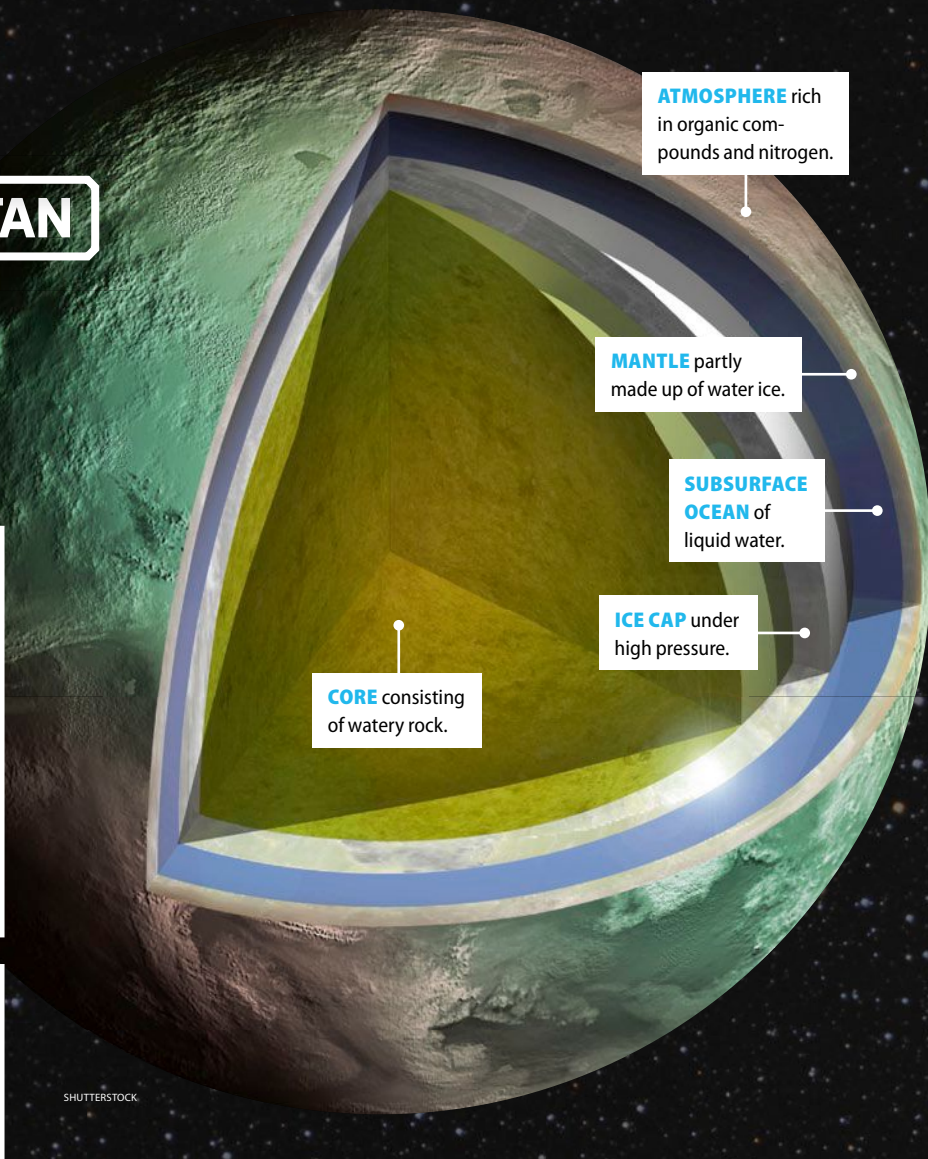
The environment in Titan's methane lakes is much like the conditions on Earth billions of years ago... except much colder.



Clouds move above Titan's northern and southern hemispheres, and from time to time, storms ravage the Saturnian moon.

► bigger space probe: Cassini. Today, Cassini is still orbiting Saturn, regularly sending news about Titan back to the astronomers, who are surprised over and over about the similarities of the Saturnian moon and Earth.

New data from Cassini has revealed that, like Earth, Titan has seasons. One year on Titan lasts 30 years on Earth. So, every season lasts about seven Earth years, and the summer is now coming to Titan's



ATMOSPHERE rich in organic compounds and nitrogen.

MANTLE partly made up of water ice.

SUBSURFACE OCEAN of liquid water.

ICE CAP under high pressure.

CORE consisting of watery rock.

northern hemisphere. By comparing data from five Cassini flybys of Titan's second largest methane lake, Ligeia Mare, scientists discovered that the surface of the lake changes with the seasons. According to scientists, the changes are due to melting methane icebergs.

CLOUDS, WIND, AND OCEAN

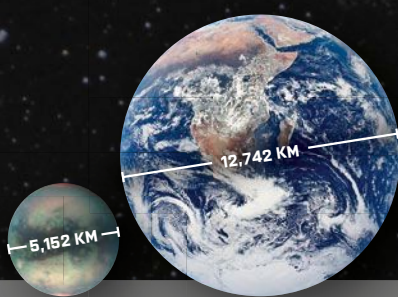
Apart from changing seasons, Titan also has a weather system reminiscent of Earth's, including both wind and clouds. New images from Cassini revealed fast-moving clouds above Titan's northern hemisphere.

Hundreds of lakes are scattered across the moon's north pole, and astronomers describe the region as one of the most Earth-like places in the Solar System. The clouds could have formed, because summer and resulting summer storms are coming up. In

the first years after Cassini went into orbit around Saturn in 2004, scientists often observed clouds near Titan's south pole, where it was summer at the time. The scientists continued to observe clouds, as spring came in Titan's northern hemisphere. But ever since a violent storm in 2010, astronomers have observed very few clouds, which is surprising, as the temperature shift should have caused more storms.

TITAN'S SURFACE FREEZES

Though Titan has much in common with Earth, the interior of the moon is markedly different. Earth's interior is red-hot, whereas Titan's is probably cold. The core of the moon is surrounded by an ice cap under huge pressure, and outside the ice cap, a vast, subsurface ocean covers the moon. New analyses of data collected during Cassini's



SIMILAR TO EARTH?

● **Liquid on the surface**

On Titan, methane and ethane take up the role played by water on Earth. The rain consists of methane drops.

● **Lakes and rivers**

Titan is the only other known place in the solar system that has stable lakes on its surface.

● **Atmosphere**

Titan's atmosphere contains many organic substances and resembles Earth, when life first originated.

● **Mountains**

Radar images taken by the Cassini probe show that Titan's surface is covered with mountains and valleys.

● **Wind**

Scientists have observed violent storms on Titan. The storms are probably seasonal.

● **Clouds**

Scientists have observed clouds at the north and south poles.

● **Tides**

The moon's subsurface ocean can rise and fall by more than 10 m – just like tidal changes on Earth.

● **Seasonal changes**

The seasons change every 7 years on Titan. One year is equivalent to no less than 30 years on Earth.

10+ year mission show that the salt content of the subsurface ocean is probably very high, like the Dead Sea. Moreover, new studies indicate that the moon's exterior mantle, which partly consists of water ice, is crystallising, freezing into solid ice.

Astronomers are fascinated by Titan, as the moon's Earth-like qualities have made them wonder about the chances of finding life. But the fact that the exterior mantle is turning into solid ice is bad news for scientists. If the subsurface ocean is covered

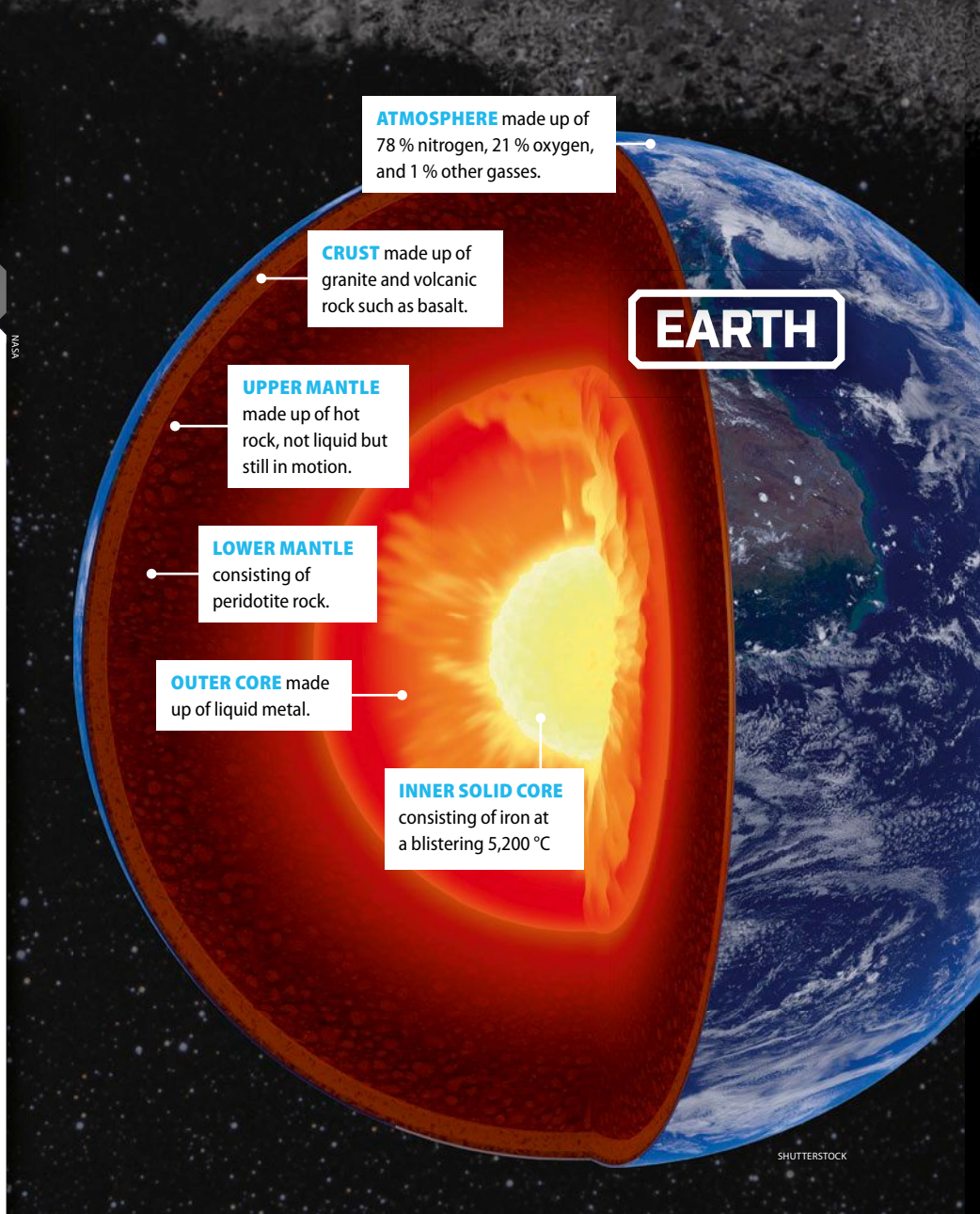
by a solid ice cap, there will be very little exchange of material between the surface and the ocean, markedly reducing the chances of finding life.

SEARCH FOR BUILDING BLOCKS OF LIFE

Though the chances of finding life on Titan are very limited, according to scientists, the moon may provide us with new knowledge about the origin of life on Earth. New research demonstrates that the young Earth's atmosphere was much like Titan's oxygen-poor atmosphere. Today, Earth's atmosphere contains 78% nitrogen and 21% oxygen (plus a mix of other gases). But studies of ancient rock in South Africa have shown that oxygen was scarce on Earth 2.5+ billion years ago, when the atmosphere was reminiscent of Titan's. Also, scientists have

found evidence that the building blocks of DNA, RNA, and a series of amino acids included in proteins exist in Titan's atmosphere. So, they think that life on Earth may have originated in the rocks and not only in the ancient soup of the oceans, which many scientists used to believe.

To study the connection between Titan and the young Earth in more detail, NASA has just provided funding for a pilot project that will ultimately send an unmanned submersible to the bottom of Titan's biggest methane lake, Kraken Mare. When life originated on Earth some 3.8 billion years ago, the primary nutrients of the oceans were methane and hydrogen sulphide, which flowed out of Earth's interior. The sub would study the make-up of this 300-m-deep methane lake, searching for the building blocks of life. **SCI**

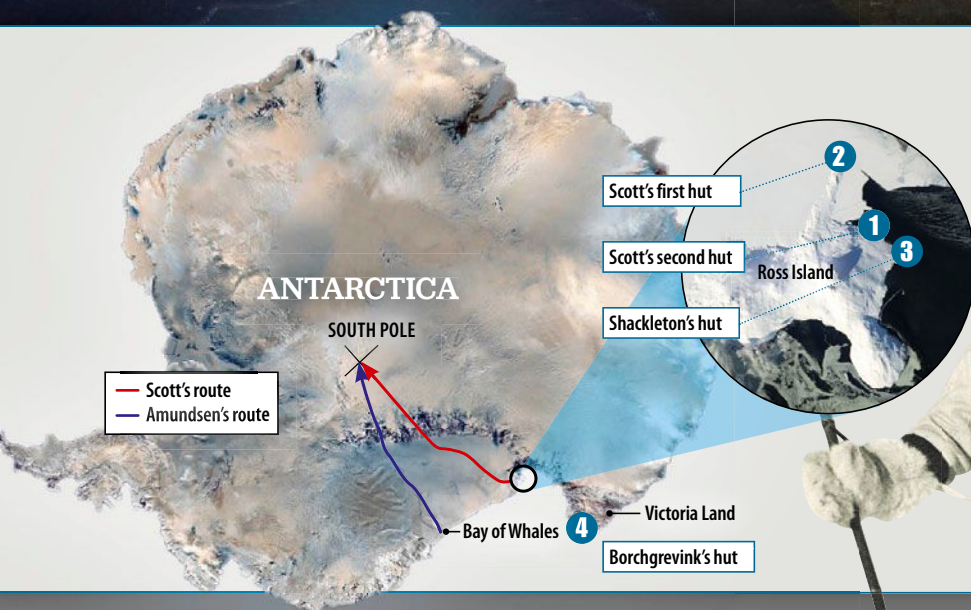


Simple human artefacts help us

REMEMBER THE MEN WHO WENT SOUTH

By Peter Eberhardt

PETER BECKENF
The bunkhouse in Robert Scott's hut from the Terra Nova expedition in 1910-13 was a cold dark home for 25 men.

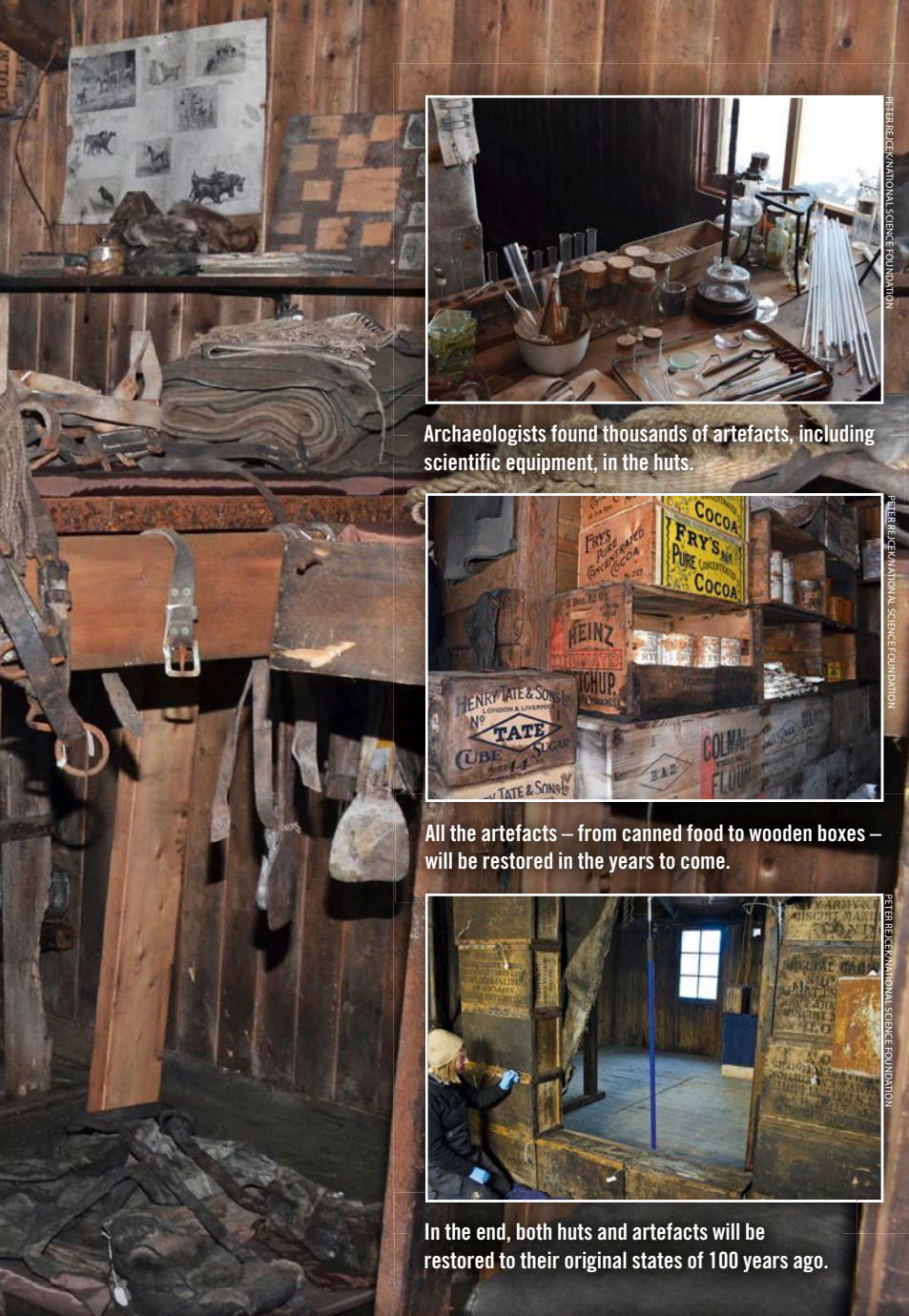


The huts are located in two regions

The preservation project will restore three huts on Ross Island and one in Victoria Land.

NASJONALBIBLIOTEKET & SCANPIX





Archaeologists found thousands of artefacts, including scientific equipment, in the huts.

All the artefacts – from canned food to wooden boxes – will be restored in the years to come.

In the end, both huts and artefacts will be restored to their original states of 100 years ago.

Tonnes of ice and meltwater threaten the first polar explorers' wooden huts in Antarctica. A team of scientists have gone to the unforgiving, ice-locked wilderness to save the huts and thousands of artefacts, left untouched on the icy continent for 100 years.

A hundred years. That is how long the first polar explorers' wooden huts have survived snow and storms on the world's coldest, most remote and least hospitable continent.

In recent decades, rising summer temperatures have caused meltwater to flood the primitive wooden bases, while cycles of freeze and thaw have accumulated tonnes of ice beneath the floors. The wooden structures have long been in such a bad state that the historical huts will be lost for good, if something is not done fast.

A decade ago, archaeologists from the Antarctic Heritage Trust went to Antarctica to save four of the exposed huts. Three of them have been restored, and the archaeologists have now turned to the last hut and the thousands of artefacts that have emerged along the way. ►

An icy, lethal race

The huts provided heat and shelter during the first polar explorers' highly dangerous race to the South Pole.

In the first decade after 1900, several polar explorers strive to be the first to reach the South Pole. In 1908, Ernest Shackleton's attempt fails. Three years later, two polar exploration megastars turn the race into a full-blooded duel.

In the race, which lasts several months, Roald Amundsen of Norway competes against Robert Falcon Scott of the UK. Roald Amundsen leaves his hut in the Bay

of Whales on 20 October 1911, and on 14 December, his team is the first ever to reach the geographical south pole.

Scott's team reaches the South Pole one month later, only to head back for the hut on Ross Island in a hungry and freezing state. All five explorers die. Scott and two of his men are the last to expire, only one day from supplies and less than 180 km from the food and warmth of the hut.

Today, Amundsen's hut no longer exists.



Amundsen

Amundsen of Norway was the first to reach the South Pole on 14 December 1911.



All metal pipes, including those from wood burners, are restored to their original states, and any rust is removed.



Each artefact in the huts is numbered and will subsequently be conserved, so they appear brand new.

Five step restoration

Everything in the huts is carefully numbered and conserved. The demanding task is carried out in 5 steps:

- 1. Foundation:** Meltwater is drained off, and the foundation is wrapped in rubber.
- 2. Floors:** Accumulated ice beneath the hut is removed. Walls and floors are carefully dried by high-grade dehumidifiers.
- 3. Roof:** Steel beams are inserted into the roof, drains are mounted, and the roof is covered in rubber.
- 4. Walls:** Insulation is placed between exterior and interior walls.
- 5. Artefacts:** Scientific equipment, books, clothes, and supplies are conserved.

► TONNES OF ICE BENEATH THE FLOOR

When the first expeditions reached Antarctica more than 100 years ago, the huts were of vital importance. The pioneers needed bases, where the indoor winter temperature could be kept as high as zero degrees by means of wood burners and stoves and where their tonnes of equipment and supplies could be stored. The prefabricated huts could be erected

fast, so the adventurers were sheltered during the winters.

But in the past 100 years, the huts have been exposed to the elements. Beneath the huts, 20-40 tonnes of ice have accumulated, walls and floors are wet, the wooden structures are creaking, and meltwater seeps into the foundations.

The renovation project began in 2004, when specialists began to work on polar explorer Ernest Shackleton's hut, which was

The Project

Only six huts from the early exploration of Antarctica still exist, and four of those are restored. Two were used by Robert F. Scott, and the others were used by Ernest Shackleton and Carsten Borchgrevink.

1 SCOTT'S HUT 2

Expedition: Terra Nova.
Headed by: Robert Falcon Scott, UK.
When: 1910-13.
Where: Ross Island.
Artefacts: 8,500+.
Renovation status: Done. Artefacts restored in 2015.

I. McLAUGHLIN/ARCTIC PHOTO



built for his Nimrod expedition in 1907-09. During four Antarctic summers, an international team of specialists worked hard for six months at a time to return the hut at Cape Royds on Ross Island to how it appeared 100 years ago.

Recently, the archaeologists finished the conservation of two of British polar explorer Robert Scott's huts on Ross Island, which were used in 1901-1913, but the almost 9,000 artefacts still need to be conserved.

This year, the team will start working on the fourth hut, which was erected in Victoria Land in connection with Carsten Borchgrevink of Norway's Southern Cross expedition in 1898-1900.

NEW WINDOWS REMOVED

The four huts show more or less the same symptoms, and so, the renovation process is almost the same for all of them.

First, the archaeologists safeguard the huts against further damage caused by the harsh climate. They drain off the meltwater, remove the ice beneath the huts, and dry waterlogged beams, before wrapping the roof and foundations in rubber, stabilising the building's supporting structures.

The next task consists in restoring the huts to their original states. In the 1970s, several structural parts, including doors, windows, and wood casing, were replaced by new materials. Based on drawings of the huts, the parts will be replaced by period-correct recreations using original wood types and shapes. Each and every nail of ceilings, walls, and floors will be carefully removed

and straightened out before being hammered back into the original nail holes. After that, the archaeologists start working on all the metal pipes of wood burners, stoves and more, which have been bent over time due to the pressure exerted by the ice on the huts. The parts are carefully restored to their original shapes, and rust is removed.

Finally, the thousands of artefacts left by the old expeditions are conserved, so they appear to be new. The artefacts are anything from canned food to beds and scientific equipment. The general idea of the extensive renovation project is to display the huts and their contents as they were, when the pioneers lived in them. Everything from seal

blubber stains to worn-out leather straps will therefore remain in the huts. Other scientists have lived there over the years, moving things about, but based on photos, furniture and artefacts are now in the original spots.

ANOTHER 100 YEARS

When the expeditions were planned, not many people imagined that the prefabricated huts would still be standing 100 years later. But today, the huts are in a very good shape, and only the restoration of the last hut and the thousands of artefacts remain. The work is expected to be completed in 2015, and time will show, if the huts can last another 100 years. **SCI**


ANTARCTIC HERITAGE IS NO MAN'S LAND

The United Nations (UN) has no real influence on Antarctica, and so, the continent is a kind of no man's land. That is also true for the historic huts, which the polar explorers left behind 100 years ago.

UNESCO, the United Nations Educational, Scientific, and Cultural Organisation, which takes care of many preservation-worthy monuments and locations, therefore has no budget for the huts. Instead, the private Antarctic Heritage Trust of New Zealand is



responsible for the restoration, depending on foundations, investors, and donations to be able to carry out the renovation of the huts.



2 SCOTT'S HUT 1
Expedition: Discovery.
Headed by: Robert Falcon Scott, UK.
When: 1901-04.
Where: Ross Island.
Artefacts: 350.
Renovation status: Completed in 2014.

PETER REICHERT/NATIONAL SCIENCE FOUNDATION



3 SHACKLETON'S HUT
Expedition: Nimrod.
Headed by: E. Shackleton, Ireland/UK.
When: 1907-09.
Where: Ross Island.
Artefacts: 6,000+.
Renovation status: Completed in 2008.

RALPH HARRIS/NATIONAL SCIENCE FOUNDATION



4 BORCHGREVINK'S HUT
Expedition: Southern Cross.
Headed by: C. Borchgrevink, Norway.
When: 1898-1900.
Where: Victoria Land.
Artefacts: 1,000+.
Renovation status: Four year project starts now.

BRYAN AND CHERRY ALEXANDER/SCANPIX



Beyond the Rock

Discovering the full extent, beauty and mystery of the Uluru-Kata Tjuta National Park.

Words and photography by Damon Wilder

Many Colours

Depending on the time of the day and the weather, Uluru can appear in all manner of colours, from a pale orange brown to charcoal grey to deep chocolate. In this dawn photo, it takes on a rich fiery red complexion as light filters through the atmosphere.

Flowers, flowers everywhere. I arrived in Uluru-Kata Tjuta National Park a month after an uncharacteristically wet winter. The barren expanses of red dirt an dry weeds that I had imagined were instead dotted with wildflowers in their thousands, many of which, I discovered, had not been seen in bloom for decades.

The park is one of only a handful of sites around the globe that holds World

Heritage status both for natural value and cultural significance. Uluru itself truly is an awe-inspiring sight. No matter how many remarkable photos have been taken of this iconic monolith, nothing compares to the experience of seeing it up close.

Though I try, the sheer scale of it is something that simply can't be expressed in a photo. Uluru stands 348 metres above the surrounding countryside, with a ►



► circumference a little more than nine kilometres. Kata Tjuta, about 40 kilometres away as the crow flies, stands even taller reaching 546 metres at its highest point.

This is quite literally a mythical landscape. To the local Anangu people, Uluru has been a sacred place for millennia. Humans have inhabited this part of Australia for well over 30,000 years. Many locations around the base of Uluru are traditional sites allowed to be seen and visited only by Anangu, with specific places exclusive to men, and others for women.

Europeans have propagated their own myths and misconceptions about the Rock and the neighbouring Kata Tjuta formation. The most commonly told story is that Uluru is the world's largest freestanding rock. In fact this is not the case at all. Uluru is actually the exposed end of an underground formation, which started to develop several hundred million years ago. The formation is a hundred kilometres wide and extends more than five kilometres below the desert floor.

Despite their close proximity Uluru and Kata Tjuta are not connected. Kata Tjuta, like Uluru is the tip of another separate ancient rock formation. Even to the untrained geological eye, the two have very different



▲ **Layer of Rust**

Uluru is rusty! The familiar colour of Uluru is only skin-deep and the result of an oxidised layer or patina on the surface of the rock. When chunks of rock flake off the surface they leave behind a temporary dark grey scar, the natural colour of the rock beneath. With time this patch too will oxidise, restoring the distinctively coloured outer layer.

◀ **Desert Dwellers**

Desert Oaks dominate the landscape throughout the Uluru Kata Tjuta National Park. Superficially they resemble pines with their needle-like leaves and fruiting cones. The narrow leaves help preserve unnecessary moisture loss and the trees grow long taproots up to four times the height of the tree to reach the water table deep below the parched earth.



▲ **Rare Blooms**

Following periods of heavy rain the desert is awash with colour from wildflowers, like these blue pincushions, that sprout seemingly from nowhere. Some species may be totally absent from the landscape for several years, laying dormant as seeds until a suitable level of rainfall triggers their germination. Then, the country is transformed.

▼ **Dry Flowers**

Other species, like these white paper daisies, are well adapted to survive on minimal water and even after the foliage has withered and dried up the flowers remain blooming for weeks. What appear to be white petals are actually bracts that contain almost no moisture. These tough dry bracts protect the many tiny flowers that form the yellow centre until they are fully developed.



A Dance of Dragons

A central netted dragon (*Ctenophorus nuchalis*) interrupts its home expansion for a brief moment to survey the surroundings for potential predators. These lizards spend much of the day basking in the sun within a safe distance from their numerous burrows. When threatened they will entomb themselves, blocking the entrance of their burrows to prevent predators getting in.



Cryptic Crickets

An unidentified grasshopper species attempts to remain unidentified. Many of the desert species exhibit intricate cryptic markings making them almost invisible even at close range.

composition. Uluru is predominantly composed of a sandstone known as Arkose. The presence of iron oxide means that the outer surface is effectively covered in a layer of rust, hence its iconic colour.

Kata Tjuta on the other hand is made of conglomerate rock. As the name suggests it contains all manner of pebbles, rocks, boulders and sand all compressed over hundreds of millions of years into a solid slab.

LIFE IN THE DESERT

As harsh as the climate may be in this remote region of Australia, there is a rich and flourishing biodiversity. Many species are uniquely adapted to this environment, while others like dingoes are extremely adaptable and able to eke out a living in practically any of Australia's diverse landscapes. Birds are very well represented in the park with 178 known species described so far. Reptiles too are ►

▼ **Apex Predator**

Perenties - a goanna species - are Australia's largest lizard. Fully grown they can reach lengths of up to 2.5 metres. They are opportunistic hunters and are just as happy eating roadkill as they are attacking and consuming almost any small animal they can overpower.



► particularly well adapted to this environment with 73 species identified to date.

As much as we may perceive this part of Australia to be a barren dry landscape, the Australian desert experiences a much greater rainfall than many of the world's other major deserts. Over 400 species of plants grow around Uluru and Kata Tjuta. The hardiest ones are present year-round and have adapted to tap into the groundwater reserves deep below the surface, or grow leaves that hold very little water. Many other species can lay dormant as seeds in the dust for years until a suitable downpour awakens them.

I experienced the full gamut of weather during my six-day visit to Uluru. The change from blistering hot cloudless days occurred extremely rapidly and what looked at sunrise to be another scorching day turned into a two-day torrential downpour within a scant handful of hours.

Of all of Australia's wonderful landmarks, I would urge all our readers to visit and experience Uluru for themselves. Even cynical scientifically minded individuals like myself can't help but feel a sense of awe here, and Uluru's spiritual significance for the Anangu becomes palpable. **SCI**



◀ **Bush Tucker**

There are a number of species of bush tomatoes native to Central Australia. Many of them are edible and have long been a valuable food source for the indigenous population. Like cultivated tomatoes however, bush tomatoes are members of the nightshade family, of which many members are highly toxic. A case of mistaken identity between species can easily result in severe poisoning.



◀ **Sweet Treat**

Honey grevillea is a very important food source for all manner of species in the desert - including humans. The sticky sweet nectar provides essential sustenance for insects and birds and has long been a popular treat for the traditional owners. The flowers are soaked in water to produce a sweet refreshing drink.



Castles of Stone

25 kilometres from Uluru, Kata Tjuta is made up of a series of peaks. The tallest, Mt Olga towers some 540 metres over the surrounding countryside. Uluru measures 348 metres tall at its highest point. That's still taller than the Eiffel Tower.

◀ **After the Fire**

Desert Bloodwoods, a member of the eucalyptus family, are the tallest trees in this part of the outback. They have very thick fire resistant bark, but sometimes the flames get the better of them. The skeletal hardwood remains of these trees is a testament to a fire from long ago.

THE CONNECTING THREAD

History is full of breakthroughs and inventions, each of which lead to very different, innovative creations by a roundabout route. Follow the connecting thread!

By Else Christensen

From seawater ...

Alchemists invent distillation device

200 CE

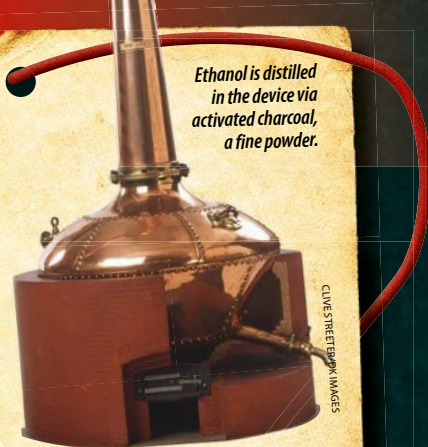
When the city is under Greek control, Alexandria in Egypt is inhabited by lots of alchemists, the scientific pioneers of the era. The scientists are particularly famous for trying to make gold from lead, but they also experiment with chemistry and physics. One experiment is about **purifying water** by boiling and subsequently making it evaporate inside a transparent alembic. Records made by the alchemist Zosimos show that around 200 CE, the Greeks in Alexandria use the method for turning seawater into drinking water.



Chemist makes pure ethanol

1796

In the 1200s, ethanol is extracted using a distillation device. The ethanol is made from hydrogen, oxygen, and carbon, when sugar ferments. But it is not pure and may contain toxic by-products from the fermentation. The problem is solved by Johann Tobias Lowitz, who distills ethanol in 1796 **via fine carbon powder**, that absorbs the impurities.



Ethanol is distilled in the device via activated charcoal, a fine powder.

CLIVE STREET/PHOTON IMAGES

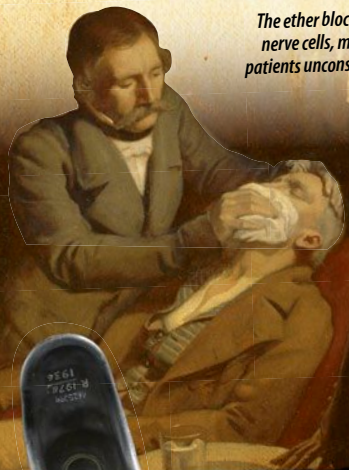
CHRISTIAN BARTIG/GETTY IMAGES

Ether revolutionises medical science

1846

In the mid-1800s, ethanol can be made artificially from a plant substance. One of the by-products of the process is ether, which turns out to have qualities of its own. On 16 October 1846, American dentist Edward Morton soaks a sponge in ether and places it in a glass inhalator for his patient to breathe through. The patient becomes unconscious and **feels no pain**, as Edward Morton removes a tumour in his jaw. The ether works by affecting the central nervous system.

The ether blocks the nerve cells, making patients unconscious.



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Phenol kills bacteria

1867

Using ether, doctors can carry out complex surgery, but many patients die afterwards of so-called wound fever – or blood poisoning. Inspired by Pasteur's theory about food decay being caused by microorganisms, surgeon Joseph Lister begins to **cleanse surgical instruments** and patients' wounds using weak phenol acid to prevent infection. It kills bacteria and prevents blood poisoning.

After Lister starts using phenol for cleansing purposes, the number of infections after surgery falls by 15%.

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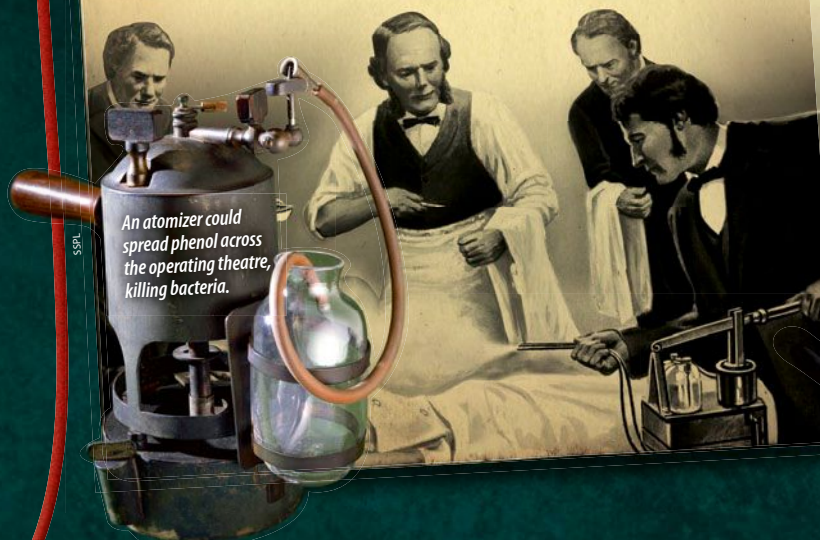


1885

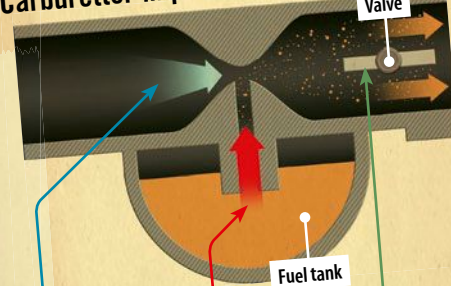
Spray powers petrol engine

Doctors have become good at using phenol for sterilisation purposes, but surgical wounds are still infected by bacteria from the air. In order to get rid of those, Joseph Lister invents a spray bottle, which can vaporise the phenol and spread it across a room. Wilhelm Maybach, an engineer, sees the

bottle and develops a carburettor, which can **vaporise petrol, blending air and fuel**, before it is injected into the engine cylinder, where the petrol is ignited by a spark, producing explosive combustion. The carburettor is first installed in a "Reitwagen", the world's first motor cycle.



Carburettor improves efficiency



- 1 Air is sucked into the carburettor. The narrow part of the tube compresses the air, increasing speed and lowering the pressure.
- 2 The reduced pressure produces a vacuum in the fuel tank, so the fuel is sucked up from the carburettor.
- 3 A valve regulates the amount of fuel and air passing from the carburettor into the engine.

The carburettor was first used in a motor cycle.

... to helicopters

Carburettor makes helicopter fly

1931

The helicopter concept has been known since 1485, when Leonardo da Vinci drew detailed plans. However, a functional helicopter did not see the light of day, until **an efficient and light petrol engine** was developed. The very first mass-produced helicopter is the R-4 model designed by a US engineer by the name of Sikorsky. It takes off for the first time in 1931. The helicopter's lift comes from a single, horizontal, main rotor, while a tail rotor pushes sideways to compensate for the torque of the main rotor. The design forms the basis of the helicopters we know today, which can fly at speeds of up to 400 km/h at an altitude of up to 12,000

metres. Until it is replaced by fuel injection, the carburettor is used in almost all other powerful forms of transport.

The carburettor provides the engine thrust required by a helicopter.

U.S. ARMY



Counter-rotating dual main rotors mean a tail rotor is no longer needed

Combat helicopter flies 400 km/h

Today computer-controlled injectors, which squirt precise mixes of petrol and air into the engine, has improved performance considerably, allowing the construction of devices such as helicopters and aeroplanes. Modern helicopters such as this Sikorsky S-97 gunship, which is under development, can fly at speeds of up to 435 km/h and take off in spite of weighing almost 5,000 kg.



TRIVIA

PUT YOUR KNOWLEDGE
TO THE TEST

1. Which family in the animal kingdom has nymph, instar and imago as part of their life cycle?
2. Once called an asteroid, what is the current astronomical classification of Ceres?
3. Which chemical element do steel and carbon-fibre have in common?
4. Tesla's latest electric car is called the Model S P84D. What does the D stand for?
5. Is a bird's sex determined by its mother or its father?
6. Which word, loved by astrologers, comes from a Greek phrase meaning "circle of animals"?
7. Which story did Hans Christian Andersen change the title from "The Young Swans" so as not to spoil the ending?
8. What kind of animal is a leveret?
9. In which of these everyday products will you NOT find styrene-butadiene synthetic rubber: car



q. 10

tyres, shoe soles, engine gaskets, waterproof linings, chewing gum.

10. Which has a more powerful engine, the 1936 Supermarine Spitfire Mk IA fighter plane, or the 2015 Koenigsegg One:1 supercar?

11. Compared to near total silence, is a 30-decibel sound 10, 100 or 1000 times more powerful (in terms of sound pressure)?

12. What made-up word describes a train that levitates a few millimetres above its track on a

powerful magnetic field?

13. Which toy company has produced enough of its plastic product for every person in the world to have 86 pieces?

14. The thirteen "root name servers" are responsible for handling every single address in what?

15. What famous mathematical problem did Sir Andrew Wiles finally solve in 1995, 358 years after it was first conjectured?

ANSWERS ON p82!

q. 10



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**BROWN TREE SNAKE****Scientific name:** *Boiga Irregularis***Distribution:** Native to far northern Australia, Papua New Guinea, eastern Indonesia, invasive species elsewhere especially Guam**Status:** Thriving on Guam and devastating the local bird population

PHOTOGRAPHY BY DAMON WILDER

A SERPENT IN PARADISE

Usually, the “invasive species” story is about how some idiot Colonial introduced a European mammal into Australia and it quickly got out of control. See: rabbits and foxes. But every now and then, an Aussie critter gets revenge.

Not on Europe though. In this case, the brown tree snake was accidentally introduced to the island of Guam during World War II. With no predators, it ate almost everything with a backbone, ruined the electricity grid by climbing power poles, and generally got in everyone's way.

As you can see from Damon's photos, *Boiga irregularis* is an attractive snake that

normally grows from 1.5-2m. Small, grooved fangs are positioned in the rear of the mouth, so most people don't receive a dose of venom if bitten. The snake is aggressive though, curling itself into a distinct S-shape when disturbed, and striking quickly. Ouch!


On Guam, the brown tree snake perfectly fits the description of “pest”. It's not really dangerous (except to small children, whose low weight makes them more susceptible to the snake's weak venom), but it gets everywhere.

The good(ish) news for Guam is that the snake's population is now starting to decline. Scientists think this could be due to restrictions in the amount of available food (they ate all the birds), a



poorly understood “reproduction suppression” mechanism, or quite simply because the snake's population has reached the carrying capacity of the island.

Solving the brown tree snake problem on Guam is something scientists don't want to rush into. History is full of warnings. After all, when researching to figure out which species could be introduced as an effective new predator of *Boiga irregularis*, one animal stood out, and it made everyone sit back and have another think.

The name of the predator? *Bufo marinus*. Better known as the cane toad. 

ANSWERS FROM PAGE 80: 1. The insects 2. A dwarf planet 3. Carbon 4. Dual-motor (it has two engines) 5. Its mother 6. Zodiac 7. The Ugly Duckling 8. A baby hare 9. Trick question: it's in all of them. 10. The car (1000kW vs the original Spitfire's 768kW) 11. 1000 times 12. Maglev 13. LEGO 14. The Internet 15. Fermat's Last Theorem

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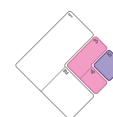
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